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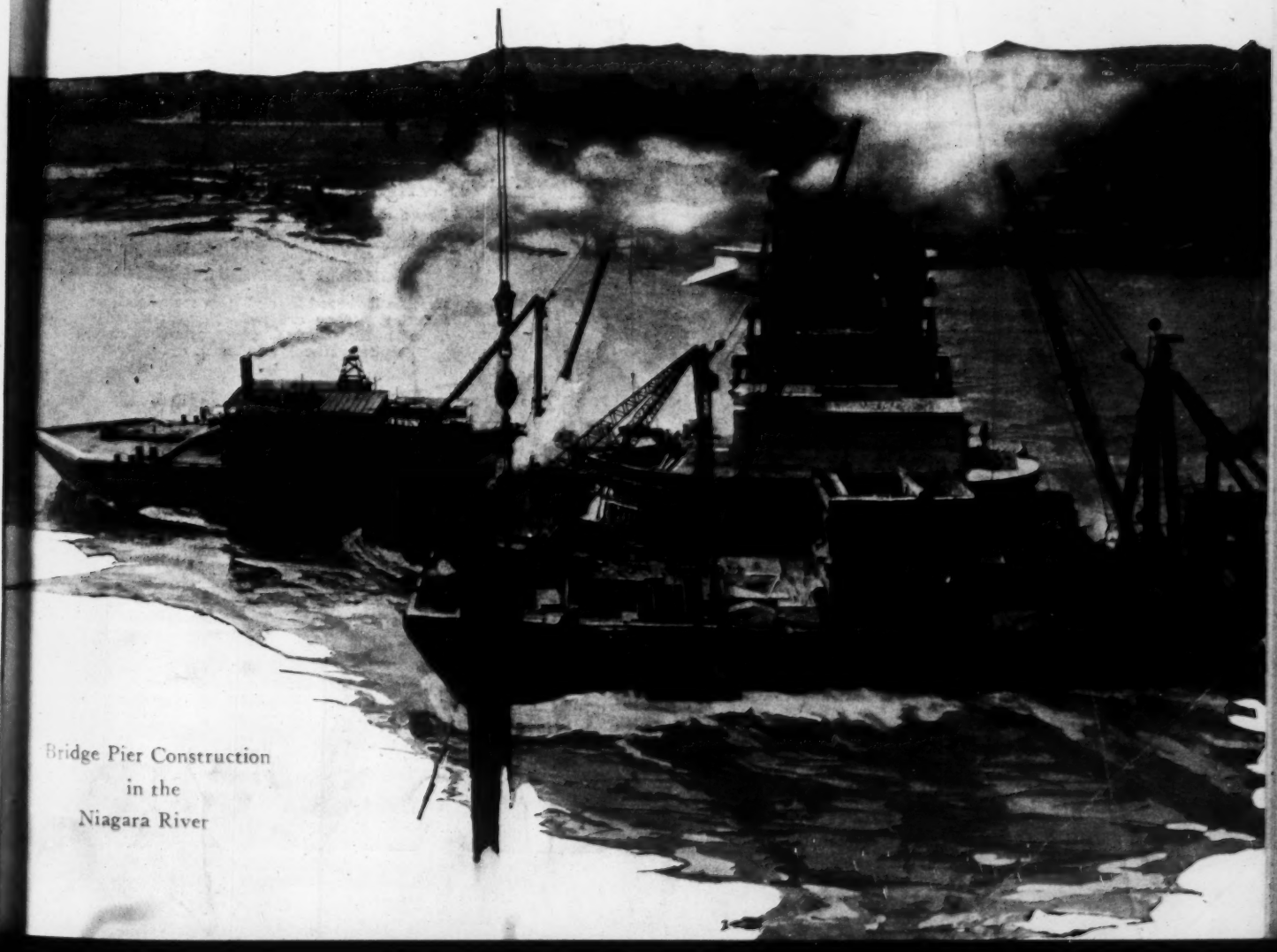
April 21, 1927

Engineering News-Record

Buffalo-Fort Erie Bridge Piers Built in Swift Water, by Reed W. Cady—Old Iron Viaduct Converted to Reinforced-Concrete Structure—Civil Engineering in the Mid-Continent Oil Field: *A continuation of the first article in this series*—Design of Concrete Mixtures on Oklahoma Dam, by Webster L. Benham



Bridge Pier Construction in the Niagara River

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FRANK C. WIGHT
Editor

Volume 98 NEW YORK, APRIL 21, 1927 Number 16

The Mississippi Breaks All Records

AS this is written most ominous reports come from the Mississippi Valley. No one can tell what is going to happen in that long stretch from Cairo to the Gulf, where hundreds of miles of earth embankment are being threatened with the press of waters. Flood records in great river basins result from a coincidence of events. The rains and the melting snows of the entire Mississippi Valley, a third of the area of continental United States, contribute to make the Mississippi River. When rainfalls so occur as to concentrate at the tributary mouths with melting snows from the north and the waters from other swollen tributaries, we have floods. Expectation of record high water in the river has always been based on something short of the worst combination of these tributary floods, but today we have almost a record flow in the upper river meeting the lower river swollen by tremendous rainfall—and the combination will produce flood heights beyond anything on record. The country will await with hope, mixed with a large degree of fear, the behavior of the levees in this threatened district.

Montreal's Typhoid Epidemic

SINCE early in March, Montreal has been writing a new and startling chapter in the history of typhoid epidemics. With its water supply filtered and chlorinated and 95 per cent of its milk supply pasteurized, the city has been having the worst typhoid outbreak that has occurred in all North America for many years. The number of cases mounted so rapidly within a few days that, in the light of past experience with typhoid outbreaks, only two vehicles of infection seemed at all likely—water and milk. Dr. S. Boucher, health director of Montreal, put the blame upon milk early in the course of the outbreak and has since given this journal the more specific opinion that "milk not properly pasteurized" is the cause of the outbreak. He also states that there was no typhoid among consumers of "raw" milk, and that only 5 per cent of the milk was unpasteurized. Through the courtesy of Dr. Boucher we expect to give details of the cause of the outbreak and a summary of governing conditions as soon as final data and opinion are available. By then we hope there can be presented more specific information than has yet been made public as to how in the year 1927 milk could be responsible for some 2,500 cases of typhoid in one city and its suburbs.

Wanted: A Fair Salary Scale

NEW YORK CITY is laying up trouble for itself in its treatment of the engineers in the city employ. Some 3,650 men are classed as engineers on the pay rolls—and their average salary is $2,600 a year! This includes all the engineering talent devoted to the city service, from the highest to the lowest, from the $1,560 "axman" to the ten directing engineers who receive over $10,000 a year. The salary scale taken as a whole is ridiculously low by any standard of measurement. It is lower than is paid in private engineering work, it is lower than prevails for public work in most other cities, it is lower than is paid to the other workers of similar ability and responsibility in the city service. So far, however, the city fathers have been obdurate in resisting any general salary scale increase for the engineers. It is not that the city is so poor that it cannot afford pay raises, for only this year material increases amounting to some millions per year were granted a miscellaneous lot of city employees. But the engineers were left out; why, no one seems to know, unless it is that as a group engineers are of little political significance. But the worm is beginning to turn. The engineers are organizing, they are gaining recognition in the daily press, the degeneracy of the city's engineering service is becoming a matter of public concern—and the Board of Estimate must soon take notice. No community is more dependent upon engineers than New York City; in no place is their handiwork more obvious. Continued hammering by the engineers on the press and the salary making bodies must in time bring results. A fair salary scale, not an exorbitant one, is all the engineers ask. And the city can hardly continue to withhold such a scale much longer.

Nicaragua in the News

PRESIDENT Coolidge called forth the spirits of the past when he asked the Secretary of War to make a thorough investigation of the feasibility of a ship canal through the Nicaraguan isthmus. Twenty-five years ago that was one of the livest subjects in engineering—and one of the most debated subjects in Congress. But diplomacy and greed and economics formed a strange alliance and the discussion as to the relative merits of Panama and Nicaragua were peremptorily ended and the Panama Canal is the result. No longer need any one argue whether one can build a canal in the fever swamps below the Chagres, no longer need the balance be drawn between the long sea level route nearer the states and the short lock canal which would mean some hundreds of miles more travel from coast to coast. The Panama Canal has been built, to be sure at a cost some three times the first estimate, but it works, it is crowded with traffic and the time is not too distant when it will be insufficient for our interoceanic travel needs. And so it behooves a far seeing administration to consider how those needs will be met, for it is a matter of history that such projects spend a generation or two in coming to fruition. It is a little difficult, however, to find anything of immediate concern in the needs for a Nicaraguan canal. The Panama route can be enlarged, at an expense perhaps a quarter of a new canal, and that enlargement would take only a small part of the cost of a new project. And if it is military requirements that press for a dual connection between oceans,

the real validity of arguments therefor need public examination. Possibly the country has a billion dollars to spend in this enterprise, but just now it doesn't look very probable. There are so many other excellent ways to spend the money.

An Engineer's Art Collection

THIS week's exhibition and dispersal sale in New York City of a portion of the art collection of the late Desmond FitzGerald shows that not all engineers are so technically narrow and so lacking in culture as is sometimes thought. The incident is more than an exception to the rule, although it must be admitted that as a class engineers give less patronage to the fine arts than do men of the other leading professions. One reason for this is that many engineers lack that permanency of home that is essential to the art collector and that conduces to an acquaintance with the fine arts. A stronger reason why few engineers, no matter how good their taste and how strong their inclination, assemble a thousand notable examples of art—in Mr. FitzGerald's case etchings, paintings and Chinese and Korean pottery—is lack of means. Mr. FitzGerald must have regarded his art treasures as a good investment for the benefit of his heirs, but to be keenly enjoyed by himself and by all who wished to visit his art gallery in Brookline during his lifetime. Eager bidders at the American Art Association galleries will doubtless give proof of his excellent taste in choosing from acknowledged masters and his vision in discerning coming artists. The collection bears eloquent testimony to the broad interests and good taste of one of the foremost engineers of the last half century.

What Is Impossible?

TO ADD PROOF to the already accepted facts that editors do not know everything and that there is nothing new under the sun, we would like to make brief reference to two succeeding pages from *Engineering News* of May 1, 1902, chanced on in reading through that old issue. On the editorial page is the following note: "A conference of aerial experts has decided upon a figure eight course over which a flight shall be made for the airship race at the St. Louis Exposition. The prizes for this race are to be $100,000 to the winner and $50,000 in subsidiary prizes. As an excellent commentary upon this item, we may quote a recent press dispatch which states that the Count Zeppelin who built some huge dirigible balloons near a Swiss lake a year or two ago, has been ruined financially by his expenditures and is now breaking up the frames of his costly toys and selling them for scrap. It requires no very prophetic eye to see the finish of the flying machine inventors who may compete for the St. Louis prizes." And on the next page is a three-column article casually describing apparatus just devised for the transmission of illustrations and photographs over the telegraph wires. The impossible is that which has never been done. Because a picture had been sent over the wire, the record of its sending was mere matter of fact, though a quarter-century later this development was being rated as epoch making in its novelty. Because man in 1902 had not flown except in awkward balloons, really to fly was then something beyond the hope of sensible men.

Education in Traffic Problems

LAST week there were two widely advertised meetings to consider the question of traffic, one at Chicago and one at New York. Both are briefly reported in our news columns. What was said at the meetings was worth while enough, some of it was new and some of it was interesting. But at neither meeting were there over 75 in attendance at any one time and the average attendance at each was nearer twenty than fifty. More than that the men who talked and the men who heard were all more or less of the same mind and where they differed there was little chance of conviction being carried to those in opposition. For they were all traffic experts, and as such well acquainted with what was to be said and like most experts "sot" in their opinion. No particular harm was done, then, by having the meetings, unless one counts the loss of time to the experts, but was there any good? This question of traffic is a serious one. There is a lot that can be done to teach those who control traffic and those who constitute it how its evils may be abated, but not much is going to result from a few experts gathered together to rehash their well known views. Traffic improvement is going to result from the extension of the Hoover Safety Conference idea into statewide and citywide movements. There is enough expert opinion on how to improve traffic to let that side of the problem rest for a while or to develop naturally. What we really need is to tell the people what these experts know—and through the people to put some intelligent ideas into the minds of our city fathers and their employees, the police.

Canal Excavators

SOME of the engineers and contractors who thirty odd years ago were confronted with the task of building America's first waterway of ship-canal dimensions, the Chicago drainage canal, and were then looking to practice at Kiel and Manchester and Suez for instruction, must have felt a reminiscent thrill at the excavation views of the Shannon River development in these pages two weeks ago. The ladder excavators and devices for embankment building so far as general appearance indicates, might have been taken over from the plant of a generation previous on the German and the English operations. Undoubtedly, the designers of the modern machines used on the Irish waterway would assert, and truly, that they represented vast improvements in mechanical detail over the machines at Manchester and Kiel which they resemble. The significance of the Irish canal excavators to the American engineer, is, however, the broader fact that excavation methods in canal construction in Europe and America exhibit today the same differences that they did when the American builders of the Chicago drainage canal were looking abroad. Then the American engineers did not copy any of the characteristic foreign practices but turned to steam shovels for power excavation. It is true that they did develop occasional weird contraptions to get the steam shovel spoil into the wastebanks, but these were few compared with the number of simple and familiar devices employed and none of them endured beyond this premier installation, and some of them were replaced almost at once. The European canal builder has had always a predilection for excavators of the type which carve out the channel to shape and fashion the embankment in

orderly form. Under his conditions it must be granted he has justified his preference by excellent work and not too high cost. Similar devices have not gained favor in America except in the single instance of trench excavators. One device after another for carving canals to shape has dropped out of use and today the canal builder, as he chose to do in the Chicago drainage canal, goes after quick and cheap quantity output by roughing out the excavation with power shovel or dragline and giving the cut form and shape by finishing operations. He finds that the method suits him as well as the neater processes of the Shannon canal apparently suit the European constructor.

Another Skyscraper Hazard

THAT outstanding development of modern times, the high building, *vulgo* skyscraper, came to notice this week as an unrealized source of danger. The Netherlands Hotel fire, reported on another page, presented an unexpected and startling picture of possible disaster. Doubtless many men have asked themselves whether in view of this fire a new skyscraper hazard must be recognized, and whether the high building as a type involves dangers so great as to make it desirable to place a severe limitation on the height of buildings.

It is a fact that the various efforts of reformers in recent years to restrict the height of high buildings for reasons of either esthetics or public convenience did not bring forward as tangible and appealing an argument as the one now presented by the proved possibility of inaccessible, uncontrollable fire. Nevertheless we believe that careful consideration of the facts warrants the conclusion that the Netherlands fire does not present a valid argument for height restriction.

To review the circumstances briefly: One of the highest of the skyscraper species, under construction and nearing completion, was the scene of a fire which went through a mass of wooden scaffolding built around its spire-like roof structure, some 400 ft. above ground. For five or six hours the fire burned, quite beyond the reach of fire-fighting efforts; meanwhile it showered debris and burning brands over its lower neighbors. The building itself suffered little damage. The fire was not hot, and most of the steelwork of the tower was already encased. The noteworthy thing about the fire was the danger to which it subjected the community round about it. By chance the night was calm and no great damage resulted. But the same happening at a time of brisk wind, and particularly in a more vulnerable neighborhood, might easily produce results of utmost gravity.

It is impossible to avoid facing the question whether our skyscraper construction is preparing for a catastrophe that might, under an evil combination of conditions, result from such a fire. Quite obviously, public safety cannot permit a fire risk of any magnitude to exist or be created in a crowded community in such a location as to remove it beyond the reach of fire fighters. Least of all may it be permitted in a situation which makes it possible for the fire to be sprayed afar over the city around it.

Such construction fires are rare—exceedingly rare. Many hundreds of high buildings have been erected without appearance of the particular danger revealed in this fire. It might be thought that the Netherlands was the first such fire, as it surely was the most spectacular, but records show a number of earlier ones. The percentage risk is small, however. So also the inherent magnitude of the risk is small, when measured by damage to the building itself; measured by the possibilities of outside effect, on the other hand, it is a very serious risk, as the recent fire showed.

Combustible materials, which create the fire risk, are very small in quantity in high building operations. Except for floor formwork there is rarely very much wood used in construction, and such as is used is not closely massed. An extensive meshwork of scaffolding as used in the Netherlands case is rare, and is probably not indispensable. Scaffolding and hoist towers, also, can be made partly or wholly of incombustible material. It is not essential to the construction of high buildings that combustible material be used in such quantity and arrangement as to offer any large fire hazard. For that residue of risk which may nevertheless be present, it is quite possible to provide fire-fighting means. Standpipes and fire pumps, hose lines, and first-aid extinguishers, supplemented by watchman service, are amply adequate to reduce the hazard virtually to the vanishing point.

Taking the worst view of the fire risk inherent in high building construction, a fire can be of only slow growth, and will be easily extinguished if seen and taken in hand promptly. Fire prevention and fire-fighting requirements are simple, and present no greater difficulties than most other questions of fire risk.

Thus, neither the fire risk itself nor the difficulty of protecting against it presents any reason for considering the high building during construction as a special hazard or problem; in fact, the outstanding factor of the case is that the risk is so small as to have escaped adequate recognition heretofore. The case of the Netherlands Hotel fire therefore does not constitute an argument against high buildings as such. It merely gives a warning reminder that building methods must not ignore or underestimate fire possibilities.

Some consideration has already been given to these possibilities. A ruling of the city's Board of Standards and Appeals some time ago established the requirement that a standpipe with siamese connection at street level be carried up with the building and be capped at its upper end so as to be ready for service at all times. The New York Board of Fire Underwriters only a month ago issued a circular warning to architects, engineers and builders on the fire risk during construction of high buildings, and urged that extinguishers and other first-aid equipment be provided. The Netherlands fire will reinforce these efforts to remove the risk.

Fire risks during construction are not confined to high buildings, but affect nearly every type of construction operation. This was emphasized only a few days after the Netherlands fire by an extensive fire in the timbering of a piece of rapid-transit subway construction on Eighth Avenue in New York, which, besides doing much direct damage, paralyzed telephone service over an extensive area and subjected water and other street services to serious risk. Construction fire protection in its entirety is a matter of sufficient public importance to warrant specialized study, and the past week's happenings make the time peculiarly opportune for initiating such study. Joint action by general contractors' associations, building congresses and the National Fire Protection Association can quickly bring into being an adequate understanding of the hazards in this field and lead to the prompt introduction of sound protective practices.

Buffalo-Fort Erie Bridge Piers Built in Swift Current

Rock Bottom and Heavy Current—Floating Caissons Placed With Help of Steel Sheet Piles and Spuds—Caisson Sealing Presented Difficulties

By Reed W. Cady,
Resident Engineer, Buffalo-Fort Erie Bridge Co.,
North Tonawanda, N. Y.

BUILDING the Peace bridge, the new highway bridge across the Niagara River between Buffalo and Fort Erie, involved the construction of three piers in the strong rapids of the Niagara River opposite Buffalo. Piers 3, 4 and 5 in the location map, Fig. 1, are in water 14 to 15 ft. deep, flowing normally at a velocity of 8 to 10 ft. per second, which during southwest wind storms increases to 10 to 12 ft. per second. During such a storm, also, the depth of water is increased some 4 ft. In view of the swift current, the hard, smooth rock bottom, which offered little opportunity for anchoring, and the fact that no work could be done or left unfinished during the time the ice leaves Lake Erie, numerous interesting problems presented themselves.

General Method—The main part of each of the three piers was to be 40x80 ft. in plan, supplemented by a granite-faced ice breaker at the upstream end, 20 ft. wide and 40 ft. long. In view of the large size of the piers, excessive cost stood in the way of adopting a cofferdam method by which the work could be done wholly in the dry. The method of sinking a floating caisson sealed by concreting under water was therefore adopted.

It was decided to use open timber caissons—the caisson being a box of the shape of the pier footing, with tight sides but without top or bottom, built rigid enough to withstand the stresses of towing and anchorage and the pressures of water and concrete. Each caisson was built on the river bank at some distance from the bridge site, launched, towed to the site, sunk in position with sufficient loading to keep it from being washed away by the swift current, and then sealed by under-water concreting and pumped out for the construction of the main body of the pier.

A contract for work on this basis was let in August, 1925, to J. P. & R. B. Porter, of Ottawa, and they began work soon after, undertaking first the construction of the caisson for pier 3. They completed their contract little more than a year later (in December, 1926) with entire success, and closely in accordance with the program of operations laid out at the beginning.

Pier 3—In the first caisson, for pier 3, the sides were built of 2x8-in. plank laid flat and spiked around a framework of bracing. The general form of construction is illustrated in Fig. 3. The caisson was built about 20 ft. high and about 2 ft. larger all around than the neat dimensions of the pier. It was built on launching ways a short distance downstream from the bridge site. As its weight was such as to give it a draft greater than 14 ft. (the depth of water at the site), pontoons were built inside, after launching, to hold it from dragging. These reduced the draft to 4 ft. and facilitated the towing.

The first problem that presented itself was to devise a method of towing the caisson to the site and holding it in position in the swift current, sinking it and holding it in place until the seal was in. At first it was thought that a nosing crib 40 to 50 ft. wide, sunk about 25 ft. upstream from the pier, would break the force of the current enough to permit handling the caisson by lines from mooring posts on the crib. The current here is a steady heavy current in the line of the axes of the piers, and a nosing crib would have set up so many cross-currents and eddies as to make it hard and perhaps impossible to handle floating plant around it. Experience later confirmed this apprehension. Also, the cost of placing a nosing crib would almost have equaled that of setting the pier caisson itself. The idea therefore was given up, even after a nosing crib had been built. Instead, a safe and dependable method of handling work of this sort was adopted, namely, the use of a winding scow equipped with a powerful steam winch and attached by a long cable to an anchor upstream in such a manner that it could wind itself up and downstream at will.

The best estimate of the pull needed indicated something like 40 tons; actually this amount was exceeded on a number of occasions. A Lidgerwood railroad type unloader was procured, with a drum that could take 3,000 ft. of 1½-in. wire line, and was mounted on the forward end of a deck scow about 38x160 ft. Two smaller hoists were bolted to the deck, side and aft, for handling lines to the tow. Anchors were set in the river and on the shores about 1,500 ft. upstream, and the ends of the 1½-in.. cable were fastened to them, leaving the scow hanging in the current like a pendulum. It hung from a bight in a cable connecting the anchors, so that it could be slid along, allowing the

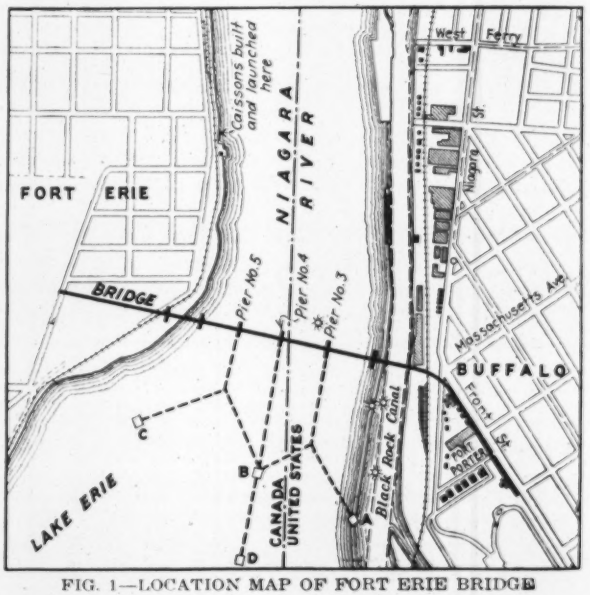


FIG. 1—LOCATION MAP OF FORT ERIE BRIDGE

scow to hang at the site of any one of the piers. This system worked excellently from the beginning and gave little trouble. It was used for hauling not only the caissons, but also scows loaded with concrete materials.

Other lines, generally 1-in. and ¾-in., were laid to hold scows and derrick boats. In all, upwards of 25,000 ft. of cable was fastened to these anchors and to shore.

The location of the anchors is indicated in the sketch map Fig. 1. Anchor *A* was a stone-filled crib on the old breakwater; *B*, the main anchor, consisted of a pair of ship anchors embedded in an 8-yd. block of concrete with reinforcement (see sketch in Fig. 3); *C* was a loop fastened around a point of rock in the river bed; and *D* was a single ship anchor that was thrown out to hold a scow while main anchor *B* was being placed.

Placing and Lining the Caisson—On Dec. 10, 1925, the first caisson had been launched; the winding scow was let down the river about 2,000 ft., where the current was less, and the caisson was attached. Previously a derrick scow had been anchored with cables and spuds just east of the pier site to act as a working boat when the caisson was being set, and a 1-in. line was brought down from this scow to assist in the towing. The main winding engine was started, and the procession moved slowly upstream without the help of tugs. After the pier site was reached, however, two days were spent pulling and hauling and juggling around to get the unwieldy caisson into position and set on the bottom.

In this operation every move had to be made very carefully; no lines could be slacked until it was sure that the others were tight and arranged so as to pull in the right direction. There were many exciting moments. For example, the caisson would be got to about the position desired when the current would catch either stern or bow and pull it around 4 or 5 ft. or roll it over on its side. The greatest strain came on the equipment just as the caisson was landed and before it was weighted, when the caisson was getting the full effect of the current for the entire water depth. However, immediately afterward it was weighted down with some 250 tons of concrete blocks and old steel forms, which snagged it on the bottom hard enough to hold.

Determining the correct location and position of the pier was done as follows: Direct measurement from a shore point was not possible, as the pier is about 450 ft. out, in a river 2,000 ft. wide. Transits were set up at two ends of a previously established base line on shore, one on the center line of the bridge and one at the far end of the line, and these sighted on three 1-in. pipes about 10 ft. long set up on the caisson, in the line of the bridge axis, as indicated by sketch in Fig. 3. The transit telescopes were set to intersect on the center of the caisson in its true position, and this not only determined the location of the caisson but also its alignment, since the transit on the bridge axis had to get the pipes in line.

It is surprising how accurate a location can be made by simple ranging, without transits. The front range should be small and the rear one detailed as a target, and both should be set plumb and as far apart as possible. The caisson could have been located accurately enough by ranging alone, but in this case only a rough location was made by ranging and then transits on the two base-line points made the fine adjustment.

Sealing the Caissons—When the caisson was finally landed on the bottom, the water surged and boiled inside of it like a millrace, because the bottom of the caisson did not fit down evenly on the irregular rock. Things were in no shape for depositing concrete by any known method. It was not even possible for a diver to go down and plug the holes. Steel piling was therefore set around the nose and down the sides to the haunches, driven down tight onto the rock, and bolted to the top of the wooden caisson. This worked out rather easily, as the caisson extended nearly to the bottom of the river, and by starting the piling at the nose and working down the two sides the pressure of the current kept the piles tight in position against the walls of the caisson, and bolting every fifth or sixth pile to the wooden wall of the caisson secured them per-

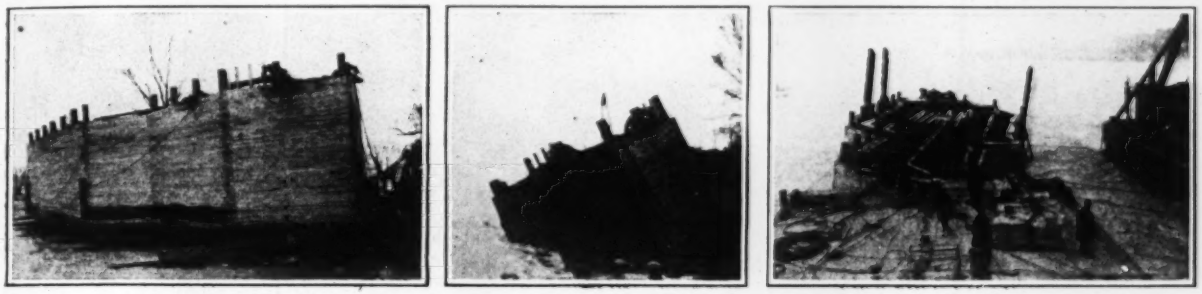


FIG. 2—EARLY STAGES OF THE CAISSON WORK ON BUFFALO-FORT ERIE BRIDGE
At left, caisson for pier 3 on the launching ways. In middle, caisson entering the water. At right, caisson at pier site, with four old steel forms 5 ft. wide serving as spuds.

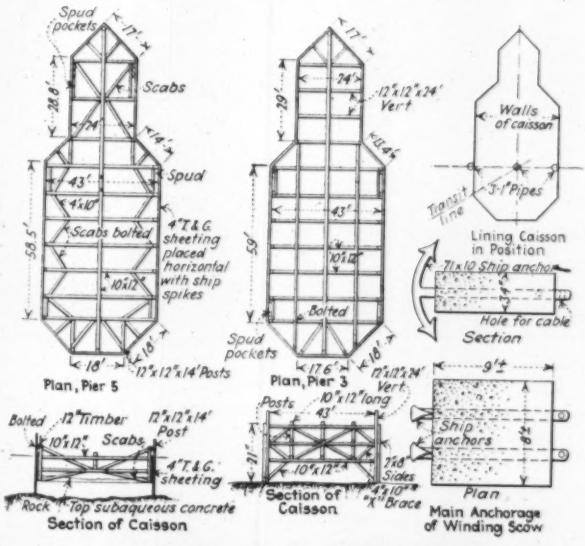


FIG. 3—CAISSON PLAN AND CONSTRUCTION
Detailed sketches show main anchor for the winding scow, and method of lining the caisson to position.

manently. These piles when driven down tight onto the rock closed off the hole between the rock and the caisson sufficiently to enable a diver to finish the work by calking with bags of cement.

After calking, the water inside the caisson was perfectly calm. Three core borings were now made to give assurance that the rock was ledge rock, and then about 8 ft. of concrete was deposited as a seal, the caisson pumped out, and the pier built up in forms inside the caisson. The seal concrete had to be placed by bottom-dump bucket, as a tremie could not be handled because of the caisson bracing.

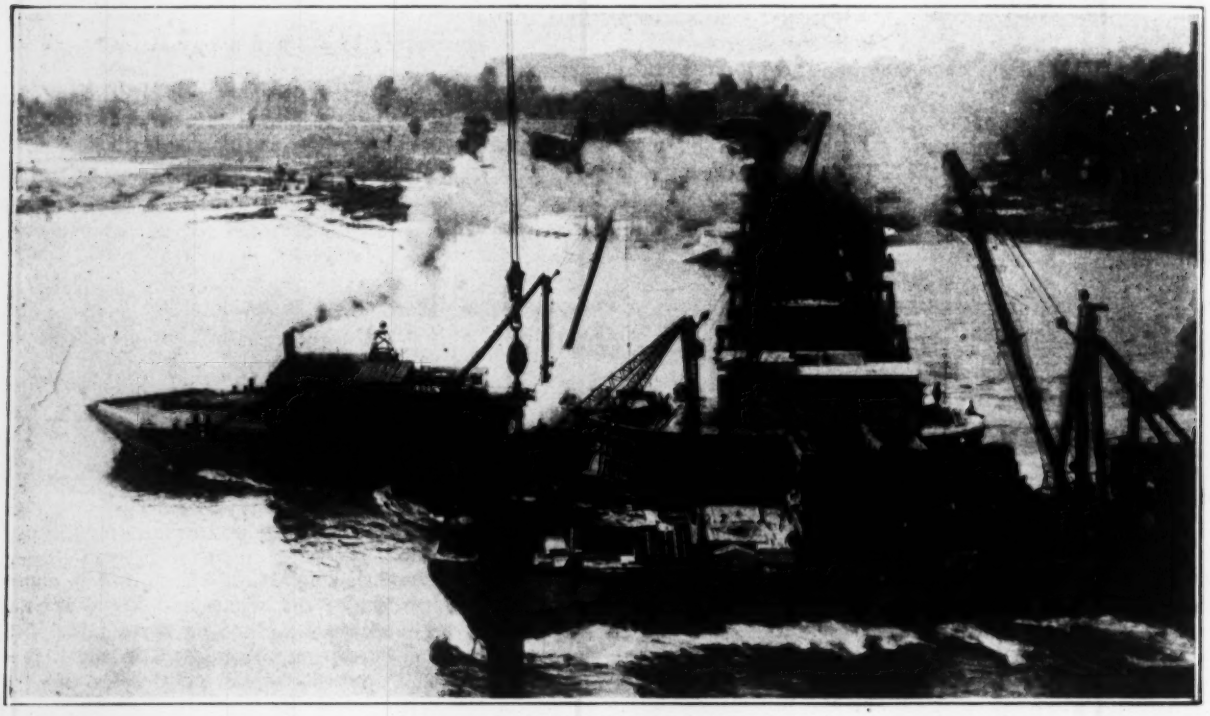


FIG. 4—GENERAL VIEW OF PIER WORK
Completing pier 5; concrete scow in foreground, steel being erected in background.

Caissons 4 and 5—After the experience with caisson 3 some changes were made in the work on piers 4 and 5. Although the water depth was as great or greater, it was decided to build the timber caissons only 10 to 12 ft. high, with a view to sinking them only part way to the bottom and making the closure by steel piling all around the outside, since it had been learned that sheeting would be necessary around the front in any event, even though the caisson was built to full depth. The changed plan made the towing easier and reduced the cost of the caissons. The side walls also were made of 4-in. tongue-and-grooved plank instead of plank laid flat to an 8-in. wall thickness. The changed construction proved to be amply strong and tight, and saved rather more than half the lumber in the caissons; caisson 3 had required nearly 80 M-ft. of lumber.

In setting these two caissons the same methods were used as had been developed with No. 3, except that when they were brought to exact position six spuds were set in pockets left on the inside walls, and all lines were kept taut until the piling was set, driven where possible and bolted to the caisson walls.

Handling the steel sheetpiling was rather different from the same operation on caisson 3. The caissons lacked 4 or 5 ft. of reaching the bottom and were held only by lines from the winding scow, which could not be loosened or changed until the caisson was at least partly self-supporting. The piling was started on the two long parallel sides first, driving and bolting being done as the work went along. In driving the piles, the idea was to get them down tight on the bottom, and have a chance also of driving some of them into cracks in the rocks. After driving the two sides of the main caisson, the parallel sides of the nose were next driven. Up to this time the piles had not increased the holding strain on the cables, as the water could flow by inside and outside unrestrained. Now, with the help of the weight and anchoring effect of the piling, it was safe to close off the nose, and then make the final closure at the downstream end. This completed, divers went down inside and calked around the edge with bags of cement, and the under-water concreting was started at once at the nose. The lines were released only after the sealing had been completed.

One great mistake was made on caissons 4 and 5. After the steel piling was set, the spuds should have been pulled. They were of such shape and set so near the sidewalls that the bucket concrete did not surround them and make a tight seal. This caused much pumping and delay, but the leaks were finally overcome, and the piers were successfully completed in December, 1926.

The total content of the three piers is 10,500 cu.yd. of concrete and 400 cu.yd. of granite. The contract cost for building them was $352,000. The bridge has been built by the Buffalo & Fort Erie Public Bridge Co., under the direction of Edward P. Lupfer of Buffalo as chief engineer. Credit for the plant layout and the various schemes devised to carry the work to a successful conclusion is due mainly to R. B. Porter for the contractor.

Theory of Spacing Cross-Joints in Concrete Roads

Unlikely That a Rational Theory for Spacing Will Ever Be Evolved That Will Be Workable in All Cases

By Roy M. Green

Manager, Western Laboratories, Inc., Lincoln, Neb.

THE THEORY of spacing cross-joints in concrete pavements was discussed by W. W. Zass in an article in *Engineering News-Record*, Jan. 6, 1927, p. 24. This discussion is based upon average values for certain properties of concrete, which is equivalent to saying that the properties of concrete are definite and known under all conditions regardless of the aggregate used and the kind of cement from which the concrete is produced. This is far from the truth as will be shown by the following discussion of the article. It will also be shown that some of the general laws of concrete, that have been evolved upon the basis of averages, are of little more than theoretical value and of interest simply as a compilation of data accumulated under very definite conditions. The fundamental assumptions that are in error in this article may be enumerated:

(1) It is not safe to assume that the expansion and contraction of concrete under service conditions will be only 0.0001 in. per inch.

(2) The true temperature range for which the slab must be designed for expansion is not 80 deg. F., but nearer 120 deg. F. under most conditions in the northern and north central parts of the United States.

(3) To assume an average coefficient of expansion of 0.0000050 is not justifiable in the light of the present information on this subject, which is extremely meager.

(4) The initial tangent modulus of elasticity used is not the correct modulus to use in this case. Also, the modulus of elasticity is so variable that each concrete should be considered as a separate problem in an analysis of this character.

Theoretical and Practical Discussed—The following is a short discussion of each of the foregoing assumptions.

(1) It is true that the experiments conducted by A. T. Goldbeck and F. H. Jackson showed that concrete in a 1:2:4 mixture, exposed to the weather, showed an expansion and contraction of only approximately 0.0001 in. per inch. (See Bulletin 532, U. S. Department of Agriculture, "The Expansion and Contraction of Concrete and Concrete Roads," pp. 6 and 7.) Now let us refer to the paper by W. K. Hatt, on "The Effect of Moisture on Concrete" (*Proceedings* of American Society of Civil Engineers," May, 1925, p. 768). Quoting from this page, "Additional beams of concrete, using Cement F, were exposed in the weather. Changes in length, and weight and the amount of rainfall, were observed, as shown in Fig. 9. A maximum contraction of 0.033 per cent occurred in 75 days." The change in moisture content in these beams was not excessive and the precipitation was fairly uniform during the duration of the tests. Mr. Hatt pointed out in a previous paragraph that this high contraction was probably due to the use of Cement F; but how is an engineer to know that he is not using that same cement in his work?

Further, let us refer to p. 11, Fig. 2, of Bulletin 126, Engineering Experiment Station, University of Illinois, on "A Study of the Effect of Moisture Content Upon the Expansion and Contraction of Plain and Reinforced Concrete." Here we find that this particular 1:2:4 concrete shows a contraction of approximately 0.03 per cent at the age of 100 days, the first 60 of which were under wet burlap and the last 40 in air with a humidity of from 40 to 60 per cent.

There are very few test records of expansion and contraction due to moisture changes but it is very doubtful if Mr. Hatt happened to strike just the combination of aggregate and cement to give the highest shrinkage. There is also no question but that different aggregates will give varying results as well as different cements. It would therefore appear that according to Mr. Hatt's experiments the shrinkage due to moisture change may be 3.3 times as great as Mr. Zass has assumed, and it is very likely that this is not the most severe condition that could be encountered. The expansion for two days' immersion on this concrete would doubtless be at least 0.02 per cent.

It is also apparent that as far as this particular property is concerned it is not safe to assume that concrete follows any general law as now produced.

(2) Mr. Zass has assumed that he need only design for a temperature range of 80 deg. F. for temperature rise producing expansion. This is true only in the case where the concrete slab does not crack due to contraction, which it always does. If the slab contracts due to a temperature of 10 deg. below zero the cracks will eventually become filled at or near that temperature, and when the slab again expands it will be impossible to return to the same position that it was in when poured. Eventually then, the slab must be designed for a temperature range of from 10 deg. below zero to 110 deg. F. if this is the temperature range to which it is exposed. This will give an expansion of 0.0072 in. per foot instead of 0.0048 in. In other words the expansion due to temperature rise is 1.5 times as great as was assumed, if we assume, with Mr. Zass, that the coefficient of expansion of the concrete is 0.0000050, which assumption we are not justified in making with the information now available, as will be shown later.

(3) It is true that Mr. Hatt shows that the thermal coefficient of expansion of a certain concrete under certain conditions will average about 0.0000050 when the temperature varies from 85 deg. F. to 140 deg. F. This value is not applicable to the discussion of Mr. Zass for two reasons, first, because the test was made upon oven dry material, and, second, because the temperature range was from 65 deg. to 140 deg. F. and should have been from 10 deg. below zero to 110 deg. F., which would have given a decidedly different result.

It should also be noted that there is a very radical change in the coefficient of expansion dependent upon the condition the concrete is in at the time of test. (See Fig. 6, p. 767, "Effect of Moisture on Concrete," *Proceedings* of American Society of Civil Engineers, May, 1925.) Counting the tests from the left of the figure, tests 2 and 4 were made upon the same aggregate and mixture, and at 60 deg. F. the coefficient of expansion on the second test is approximately 0.0000045 and on the fourth test it is approximately 0.0000060, and these were made upon exactly the same concrete.

Mr. Hatt has shown that very probably the coefficient of expansion of concrete varies directly with the temperature. If this is the case we are justified in extending these lines in each direction for a short range at

least. Let us then extend them so that we may determine the average coefficient of expansion for each test through a temperature range of from 10 deg. below zero to 110 deg. F. We get as average coefficients:

Test No.	Mixture	Age	Condition	Approx. Ave. Coef. Exp. 10° Below Zero to 110° F.
1	1:1½:3	2 mo.	Oven Dry	0.0000038
2	1:2:3	2 mo.	Wet, Immersed	0.0000042
3	1:2:3½	9 mo.	Air Dry	0.0000051
4	1:2:3	2 mo.	Air Dry	0.0000057

This series of tests on the coefficient of expansion of concrete conducted by Mr. Hatt constitutes really the only tests of any value on this subject; but it is assuming entirely too much to take these data and try to arrive at an average coefficient of expansion for any analysis of the rate of expansion when there is a difference of over 30 per cent in the results when comparing the same mixtures under different moisture conditions only. It also would be unusual if Mr. Hatt just struck upon the condition of aggregate, cement, and moisture content that would give the greatest coefficient in his test 4. In other words, it is extremely likely that a coefficient of expansion of 0.0000060 might be obtained through the temperature range that a concrete slab should be designed for. If this is the case the expansion due to temperature rise might easily be 0.00864 instead of 0.0048 in. per foot, this result being obtained by multiplying 0.0000060 by 120 deg. by 1 ft., by 12 in., or it might be 1.8 times as great as Mr. Zass assumes.

It is also apparent that all concretes of a like strength do not have the same coefficient of expansion under all conditions. In other words the coefficient of expansion of concrete is constantly changing even in the same mixture.

(4) Mr. Zass says that the modulus of elasticity given by Stanton Walker is approximately 5,000,000 for a concrete having a strength of 3,000 lb. per square inch. The modulus of elasticity that he doubtless refers to is the initial tangent modulus of elasticity. (See Bulletin 4, Structural Materials Research Laboratory, Lewis Institute, "Modulus of Elasticity of Concrete," Figs. 26 and 27, pp. 57 and 58.) If this is the correct modulus for 3,000-lb. concrete and it has that strength in 28 days, it will have a strength of 5,000 lb. per sq.in. in one year, if its strength increase with age is normal and in accordance with "Design and Control of Concrete Mixtures" (Portland Cement Association, Second Edition, p. 7, Fig. 5). If the concrete has a strength of 5,000 lb. per sq.in. in one year its initial tangent modulus of elasticity will be in excess of 7,000,000 at that time, if it follows the curves on pp. 57 and 58 referred to above.

The modulus of elasticity as well as the coefficient of expansion is very greatly affected by the condition of the concrete at the time of test. A series was run in this laboratory upon exactly the same mixtures but in one case the samples were moist and in the other they were dry. The average results of determinations on ten cylinders tested in each condition were:

Initial tangent modulus of elasticity: Wet 4,762,000
Dry 2,821,000
(One value is nearly 1.7 times as great as the other.)

The stress-deformation relation for concrete is usually a constantly changing one as the load is increased so that the initial tangent modulus of elasticity of concrete cannot be used in a study of the stress caused by expansion. However, there are certain concretes of high strength that have almost a constant relation of stress to deformation. If an investigation is being made to determine what deformation may be absorbed before rupture of the slab occurs, data must be gathered as to the total deformation of the concrete at the point of rupture and correlated with the total expansion which is likely to occur in the slab. To my knowledge this information has never been recorded in any other place than this laboratory. It is also true that the total deformation of concrete at rupture is greatly affected by the moisture condition of the concrete and the kind of aggregate and cement used. Like many of the other properties of concrete it is impossible safely to reduce the information to averages and then use the average for designing purposes of this character.

Getting back to the modulus of elasticity at the breaking load, if it is true that there is an occasional concrete that is truly elastic to its breaking load, or nearly so, then when a concrete has reached a strength of 5,000 lb. per sq.in., or more, it may have a modulus of elasticity at the breaking load of 5,500,000 or more. We have records of such values.

Assembling the case that might arise as Mr. Zass has done on p. 25, we might get the following expansion:

	Exp. per Lin.Ft., In.
Moisture change	0.00240
Temperature change	0.00864
Total change per foot of length	0.01104
Total change per inch of length	0.00092

For compressive stress in the slab we get: 5,500,000 corresponding to 0.00092; unit stress = 5,060 lb. per sq. in.

This would indicate that in certain instances concrete pavements will "blow up" due to expansion, which we know is the case. If the analysis of Mr. Zass is correct in all cases, concrete pavements would never "blow up" even without expansion joints.

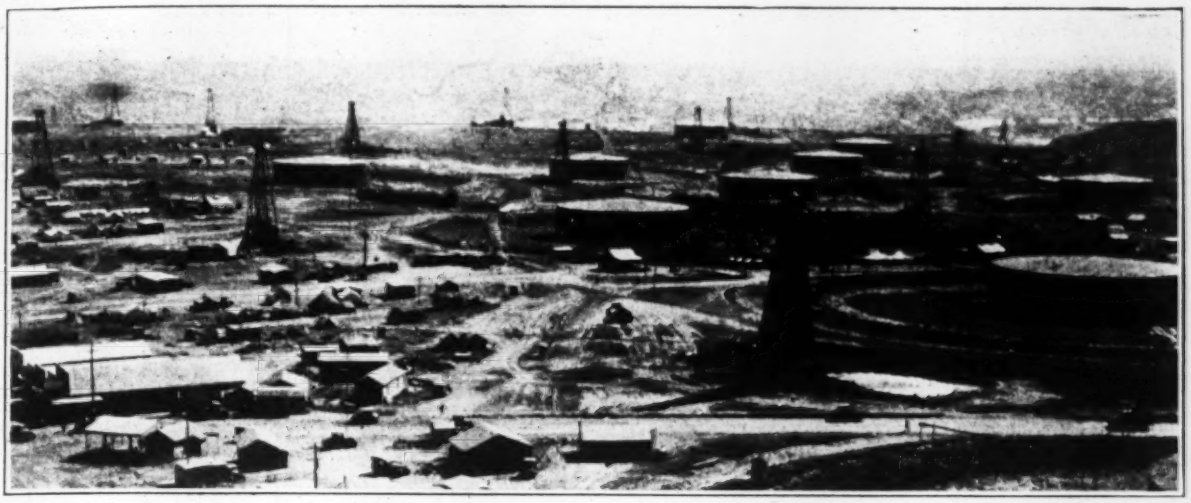
Conclusions—In summation it may be safely said that the general laws deduced for the modulus of elasticity of concrete and the data now available on expansion due to temperature rise and change in moisture content cannot safely be used for purposes of arriving at the proper spacing of cross-joints on account of the fact that the law for modulus of elasticity of concrete is based upon averages and this constant is continually changing due to the changing strength of the concrete, and the further fact, that there is a different modulus for different moisture contents, and further, the data on coefficient of expansion are so meager as to be of no value except as a record for the particular concrete tested and the particular conditions of that test. In other words, it is unlikely that a rational theory for the spacing of cross-joints will ever be evolved that will be workable in all cases as the physical properties of the concrete are different in every case and what is workable in one instance may be entirely inadequate in another.

The analysis of Mr. Zass for the location of contraction joints is logical for the average condition.

Welded Factory Building Erected in Detroit

A one-story welded building has just been erected in Detroit by the Barnes Wire Fence Co. In this work, involving 32 tons of steel, mainly 6-in. H-columns and 15 and 18-in. I-beams, fabrication was wholly eliminated. The steel was shipped direct from the mill and all work was done on the ground. City inspectors took samples of the weld made by operators in the field, and approved the work on the result of tests of these samples, supplemented by the field inspection. The welding was done with a Lincoln stable-arc welding outfit mounted on a Ford truck. The Titus Welding Co., Detroit, carried out the work.

One of a Series of Articles on
OIL FIELD ENGINEERING



Civil Engineering and Construction in the Mid-Continent Oil Fields

By Waldo G. Bowman
Assistant Editor, *Engineering News-Record*

II—Drill Rigs, Pipe Lines and Structures

A PRECEDING article, published last week, considered the oil field engineer, the scope of his civil engineering work, and the unnecessarily bad roads over which he must transport all of his materials. In this article, the subject of oil field engineering and construction is further developed to include drilling rigs, pipe line design and construction, oil field structures and equipment.

Comparing panoramic pictures of oil fields in production ten years ago and those recently drilled-in leaves the impression that not much change has been made in derrick construction. They all look alike at a distance. Closer examination shows a majority of the present-day derricks to be of steel construction. Some wood derricks are still used, but most of them use steel tension rods. Not a few use pipe struts and some of the wood legs are reinforced by steel angles. Wood columns in some cases are 10x10's, in others are built up from 2x12's.

The all-steel derrick is a comparatively recent piece of equipment. In the Mexia and the Corsicana fields in Texas, booming three or four years ago, about one in twenty of the derricks is of all-steel construction. In the Seminole field the ratio is nearly reversed, a wood derrick being the exception. The all-steel derrick is purchased complete from the manufacturers, and the fact that the derrick is now a commercial product has created one of the standardization problems of the industry. Each manufacturer has his own design, his own height (although this is determined largely by pipe casing lengths) and his own theory of what a standard derrick should be. There are said to be over 430 different sizes of derricks being manufactured. A committee of the American Petroleum Institute has recently prepared recommendations for eleven standard sizes providing six heights with one or two choices of base square. This should be of considerable benefit. The new sizes follow the time-honored practice of 24-ft. and 20-ft. square bases, but also include plans for standard bevel post derricks. Derricks of 122 ft. recently have become common on deep drilling work, so that four lengths of drill pipe could be handled.

FIG. 1—SLUSH PIT FOR ROTARY DRILLING RIG AT SEMINOLE, OKLA.

The 30,000 gal. of water required per day by each rotary drill is used again after the solids have settled out

In the Seminole field rotary drilling rigs are being used quite extensively, and are contributing much to the speed with which wells are brought in. The rotaries are used for the first 3,600 ft. and then cable tools are used for the remaining

400 ft. to the producing Wilcox sand. This procedure necessitates a change in derricks. This is done either by taking down the rotary and erecting the shorter cable tool derrick in its place, or by erecting the short derrick inside of the other and then removing the rotary structure. Foundations in the latter cases are designed with two sets of anchor bolts. The cable tool derrick is left in place after the well starts pumping.

Electricity as drilling and pumping power is spreading rapidly. It is claimed to be cheaper and to increase the drilling speed over steam operation. A high line comes into the Seminole field. In the Texas Panhandle a 10,000-kw. plant has been erected in the center of the field by one of the large public utility companies. Its only purpose is to supply current for oil field power and light. This company is building another plant in the West Texas field. Practice is to use either two 15-35-hp. motors, or one large motor, for drilling. In the first case one 15-35-hp. motor is removed when pumping commences. The larger motor in the second layout is replaced by a smaller one for pumping service.

In Seminole there has also been introduced a method of flowing wells known as the air-gas lift. Many of the wells stopped flowing and rather than resort to a costly swabbing operation, or in some cases after swabbing had failed, compressed air was introduced into the wells. Some of the results in increased production have been remarkable and to the air-gas lift is credited much of the present production of over 325,000 bbl. daily. The theory of and actual results with air-gas lift production are among the most alive and important subjects in oil production today.

There remains one other phase of oil field civil engineering carried out by producing companies. It is the construction of natural gasoline plants. Here probably the greatest yardages of concrete are poured mostly in compressor and engine bases. Chuting plants and modern methods are used. Underground storage of gasoline is necessary, and a grading and concreting operation is necessary for the tank seats. A camp of

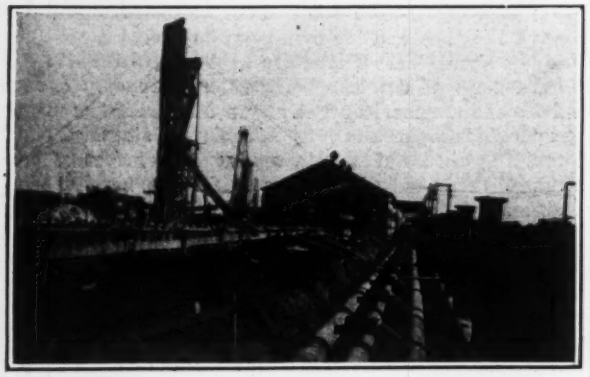


FIG. 2—BUILDING A NATURAL GASOLINE PLANT IN TEXAS PANHANDLE

rather permanent structures is usually a part of the gasoline plant layout. Portable steel frames are used for the compressor buildings and warehouses.

DISTRIBUTION

Every oil company must of necessity construct pipe lines. Most of these are short, leading only from wells to a stock tank. In the case of companies operating gasoline plants, many miles of various kinds of lines

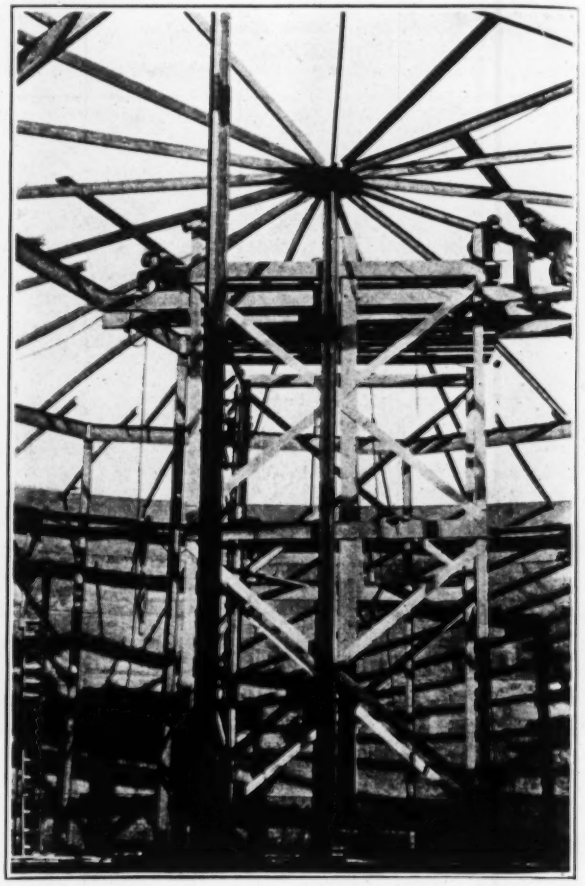


FIG. 3—ERECTING ROOF FRAMING IN A 55,000-BBL. OIL STORAGE TANK

are necessary. These include vacuum lines for bringing the gas in, crude oil pipe lines, gasoline pipe lines, mineral seal oil lines, etc., each requiring a different design basis.

But the most of the pipe lines are owned by pipe-line companies—the railroads of the oil field. It has been estimated that 70 per cent of the oil production in the United States is moved in pipe lines. The largest company having 12,000 miles of lines rivals the mileage of any of our large railroad systems. Nor does the analogy with a railway system stop with this similarity. A pipe-line company is recognized by the government as a common carrier and is subject to all rules of the Interstate Commerce Commission. It is surveyed like a railroad; it lies on a purchased right-of-way; it has trunk lines and branch lines; it has receiving yards and departure yards —the intake and discharge manifolds; it uses switches and crossovers; it requires a private telegraph and telephone system and a dispatcher.

In the design and construction of pipe lines are probably experienced the oil industry's largest problems of a civil engineering nature. A great field is open in the study of the hydraulics of viscous fluids. Several million dollars are being spent in building pipe lines out of the Texas Panhandle field, and there are people who are still skeptical as to whether they will operate or not. Presumably the pipe line companies who are spending the millions are not numbered among the doubters but the fact that the oil congeals around 55 deg. F. and contains a high percentage of sulphur is a factor

which has affected pipe line design, and concerning which accurate knowledge is not complete.

In construction, the comparative efficiency of welded and screwed joints is a live problem which seems to be settling toward all-welded lines. Pump station construction is also a camp building problem of concrete placement, housing, and water supply and sewage provisions.

Corrosion of pipe lines requires and is probably receiving more attention than any other pipe-line problem. An annual depreciation charge of 5 per cent is being used by one large pipe line company because of corrosion. On a pipe investment of $50,000,000 to $75,000,000 any per cent reduction in the annual charge would be a substantial amount. Research carried on by manufacturers and pipe-line companies has considered corrosive-resistant pipe and various sorts of pipe coverings. A committee has recently been appointed by the American Petrolum Institute to co-ordinate the now scattered research work and formulate a constructive program.

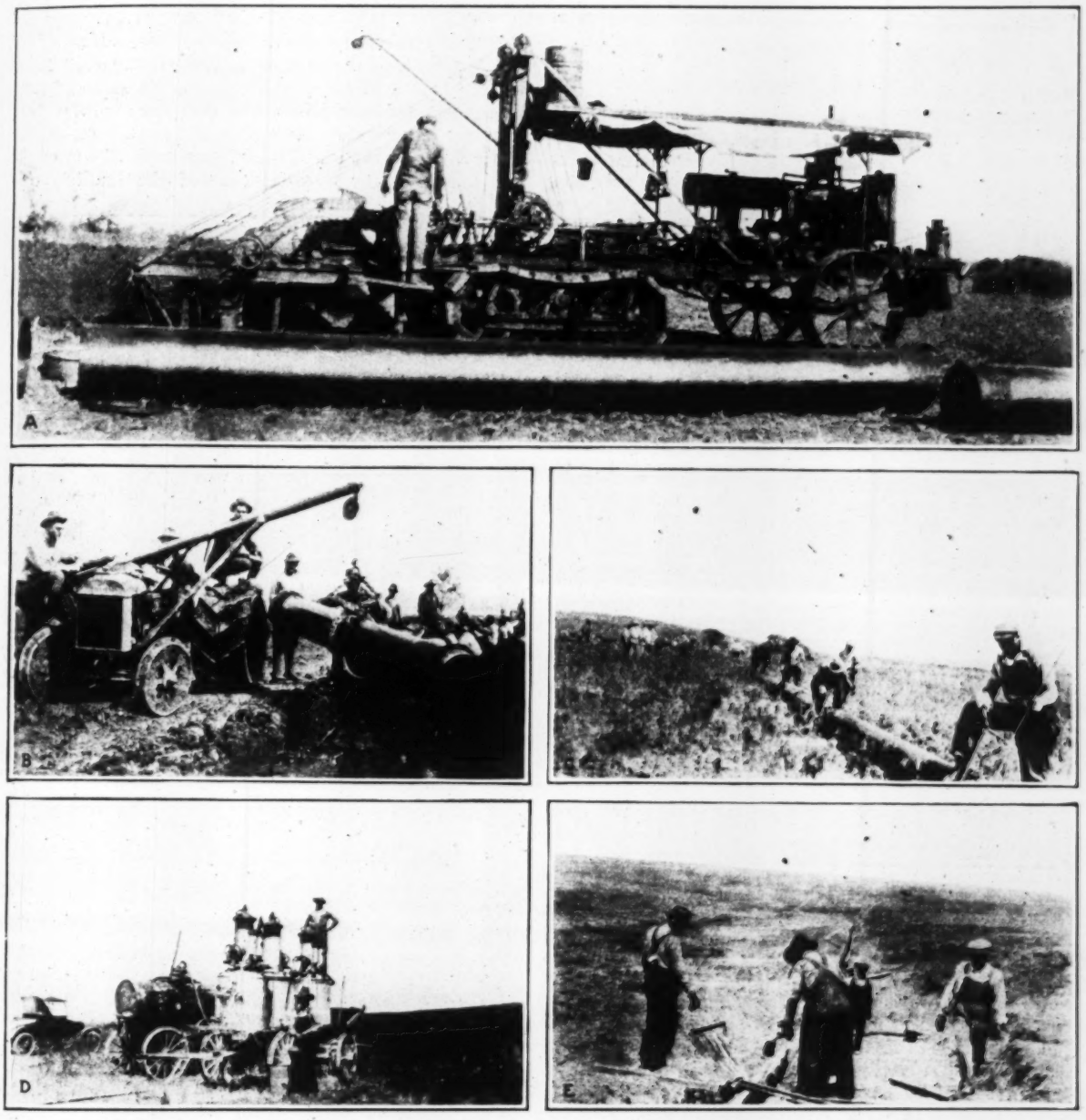


FIG. 4—BUILDING PIPE LINES FOR GAS AND OIL IS A MAJOR CONSTRUCTION PROBLEM

A. Ditching with a wheel type machine for a 20-in. gas distribution line.
B. One method of handling a 20-in. gas pipe.
C. Welding a 10-in. oil line.
D. Typical welding outfit.
E. Applying corrosive resistant paint to an oil pipe line.

Analogous to pipe covering against corrosion is the insulation used against cold. This is used on lines transporting viscous oil which has to be heated at each station. Most mid-continent oil is light and will congeal only at very low temperatures, but the oil from the Texas Panhandle field has a high content of paraffin and congeals around 55 deg. F. The plan is to heat this to around 110 deg. F. at each station along the

line and to insulate the pipe with 3 layers of tarred felt separated by applications of pitch. Construction procedure incident to this unique line will be considered in a separate article. Construction technique and civil engineering design considerations also play a part in supplying producing and pipe-line companies with telegraph systems and radio towers.

Tanks and Tank Farms

Perhaps as exacting a grading operation as is ever met exists in connection with tank farm construction. When the pipe line capacity is smaller than a field's production, or when it is desired to store oil for price advances, storage facilities become necessary. For the most part these are steel tanks, although concrete reservoirs have been used and earth basins found necessary in emergencies. The steel tanks are usually of 55,000 bbl. capacity, 114 ft. in diameter, and about 30 ft. high. They are set directly on the ground which must be graded to within an accuracy of 0.05 in. in order to guard against buckling and consequent rivet failure. The use of fire walls around each tank and the fact that often a farm includes many tanks make the grading operation one of volume as well as of care.

The design and erection of the tanks themselves constitute a civil engineering problem of some magnitude. Steel fabricators have so standardized their designs, however, that nothing more than a cursory check need be given by the purchaser. The larger tank manufacturers have developed forces of skilled erectors who do most of such structural work in the field. One of the principal problems of steel tank design is concerned with evaporation losses and, as a corollary, fire prevention. Welded roofs of vapor-tight construction are becoming quite common, and a floating roof claimed to eliminate all vapor space is finding favor.

Equipment and Power Used

As far as the use of modern labor and time-saving construction equipment is concerned, oil field work is behind general civil engineering standards. Most of the haulage contractors have been brought up on "horsepower" in the flesh. And then, too, the army of mule skinners must have jobs. The fact that crawler tractors are often more efficient and speedier on muddy roads is lost sight of. Trucks, mostly of 3½-ton capacity, are used for a great deal of the hauling over passable roads. The time saved by the use of a self-propelled crane, of concrete chuting towers, and of a dragline was the cause of much surprise by the engineers of one oil company.

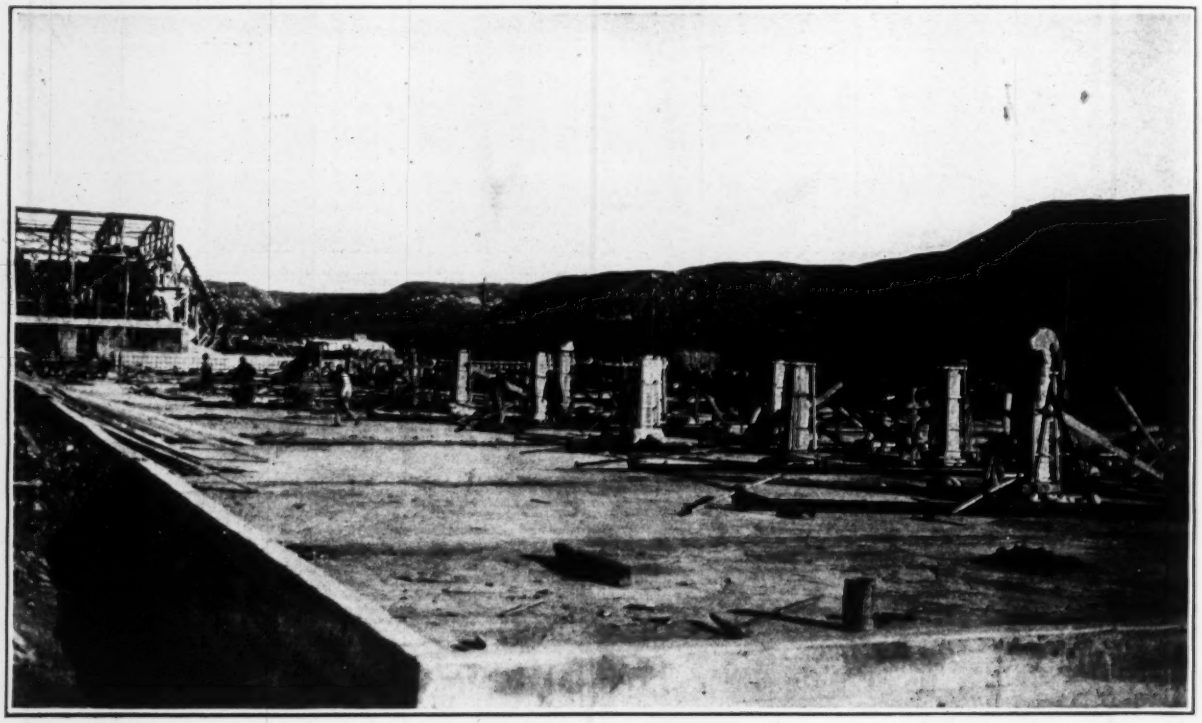


FIG. 5—BUILDING A 10,000-KW. ELECTRIC POWER PLANT IN TEXAS PANHANDLE OIL FIELD
Spray pond in foreground, power house at left. The horizon is now lined with drilling oil wells.

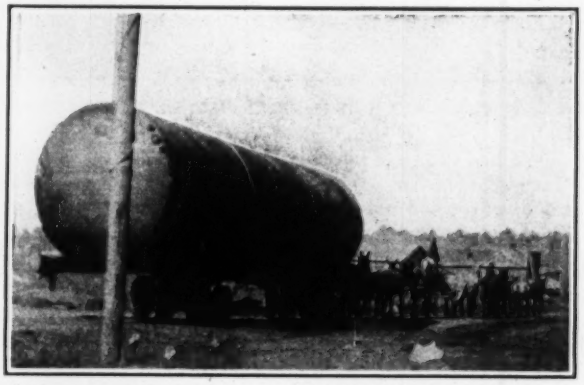


FIG. 6—HORSE POWER IS STILL USED FOR MUCH OF THE HEAVY HAULAGE

Gas is, of course, cheap, and the use of steam is still extensive. But electric drilling and pumping is decidedly on the up grade. Drillers who, being familiar with steam, would at first use nothing else, are now loud in their praise of "push-button" outfits. Special motors have been developed by the manufacturers for oil field work. One of wide application develops either 15 or 35 hp., according to the needs of the driller. The low horsepower side is used for pumping.

Compressed air finds many uses in the oil fields, and

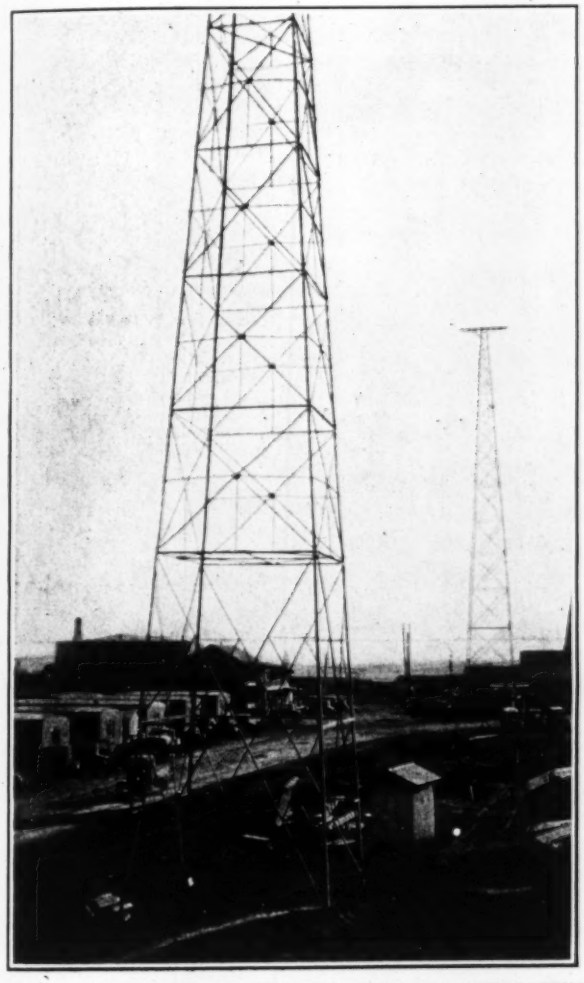


FIG. 7—PRIVATE RADIO TOWERS, PHILLIPS PETROLEUM CO. TEXAS PANHANDLE

both portable and large stationary compressors are common. Air-lift water pumping, riveting, and air flowing of oil wells are some of the larger air operations. Mud pumps of the duplex steam-driven type are commonly used. In the matter of improved drill bits, the extended use of rotary drilling has contributed much. The fish-tail bit which is probably the most used has special alloy cutting edges. Bits using cutters of a cone or roller type ars used for hard formations. The tendency toward deeper wells is placing an obligation on the sucker rod manufacturer to provide better steel. Stresses of 30,000 to 40,000 lb. per sq.in. are common, and since these stresses are repetitive, steels with high yield points must be used.

The efficiencies of pumping equipment are constantly being studied. A need is expressed for some standard method of rating engines and pumps. Bearings, both ball and roller, are improvements of recent date on oil field pumping equipment. A few installations have been made transmitting power from prime mover to pump by reduction and double reduction gears, instead of the large band wheel and belt drive.

The manufacturer plays a larger part in supplying complete units of equipment in the oil fields, than elsewhere. Portable steel-frame buildings, water softener plants, complete portable gasoline plants, tanks and factory-built houses are examples of some of this so-called "tailor-made" equipment. Speed in erection, portability, and salvage value are advantages gained while the oil company's engineers are left free to work on the larger problems of production.

As previously stated, the aggregate of civil engineering and construction work is large in the oil fields. It is, to be sure, relegated to that of an accessory to oil production and is therefore not given the study which the latter enjoys. One is forced to wonder what changes would occur in construction practices if economy (as in other construction) was a prime requisite. Where the prize is so great, however, running expenses will always be more or less disregarded. But show that modern construction methods save time, and the oil industry will use and even develop them.

Although having few civil engineering projects of large magnitude, the oil industry has its large problems of a civil engineering nature. Its engineers need the help of the rest of the profession not only in solving these problems but in creating a greater appreciation for the engineer and his capabilities on the part of oil company officials. The speculative mind and the get-it-all and get-it-quick spirit have given the civil engineer in the oil field added problems and responsibilities. To consider some of these problems as connected with specific projects in the Seminole, Okla., and Texas Panhandle field is the purpose of future articles to be published in *Engineering News-Record* on oil field engineering.

Acknowledgment for photographs, information, and transportation facilities into the fields is due the Prairie Pipe Line Co., Independence, Kansas; the Carter Oil Co., the Gypsy Oil Co., the Sheehan Pipe Line Construction Co., and the Sinclair Pipe Line Co., all of Tulsa, Okla.; the Atlantic Oil Producing Co., the Simms Oil Co., and the Magnolia Petroleum Corp. all of Dallas, Texas; the Gulf Production Co. and the Humble Oil Co., Houston, Texas; the Phillips Petroleum Co., Bartlesville, Okla.; and the Marland Refining Co., Ponca City, Okla.

Permit Refused to Construct Mt. Hood Cableway

Permission to construct the proposed cableway from Cooper spur to the top of Mt. Hood, in Oregon, has been denied by the U. S. Forester, Col. W. B. Greeley. An article describing the proposed cableway was published in *Engineering News-Record* March 17, p. 447. Colonel Greeley's decision was based not on "how conspicuous or inconspicuous the projected railway would be, or just what types of refreshment houses and other buildings for the accommodation of tourists would accompany it. It goes rather to the deep-seated regard or reverence that I believe we should preserve for mountain peaks having the grandeur and commanding position, both geographically and historically, of Mt. Hood."

Outfall Sewer Experiences in Imperial Valley

Odor Nuisance from Manholes and Imhoff Tanks and Mortar Disintegration Controlled by Keeping Sewer Full

By R. F. Goudey
Resident Engineer California State Board of Health, Los Angeles, Calif.

THE Imperial Valley cities of El Centro and Imperial, located in the extreme southeast corner of the state and founded less than twenty years ago, by singular foresight united, in 1917, to construct a joint outfall sewer leading to clarification works on the New River. In addition to such factors as torrid temperatures, a rainfall of less than 2 in. a year, a highly mineralized water supply and a sewer of large section never flowing more than half full, topography necessitated a long and fairly flat sewer, all of which accelerated destructive agencies, causing not only a gross odor nuisance, but also an alarming deterioration of the sewer structure.

The water supply for both cities is the purified Colorado River water, taken from the canal system of the Imperial Valley Irrigation District. This water has an average turbidity of about 40,000 p.p.m.; chlorides, 115 p.p.m.; alkalinity, 150, p.p.m., and a soap hardness of 325 p.p.m. Its degree of mineralization fluctuates with the rise and fall of the main river and its several tributaries, varying the chlorides from 20 to 220 p.p.m.; alkalinity, 70 to 220 p.p.m., and hardness from 145 to 600 p.p.m. The maximum mineralization may occur for thirty-day periods with air temperatures varying from 100 to 135 deg. F.

El Centro settles, filters and chlorinates its water, while Imperial, about one-third as large as El Centro, only partly settles and chlorinates. Hence the water supply contributes to the muddiness, mineralization and increased temperature of the sewage flow.

Outfall Sewer System—The combined sewered population is about 10,000 people, producing an average flow of some 0.9 m.g.d. and a maximum flow 200 per cent greater. The sewage from the lateral sewers is typically average domestic sewage in character.

El Centro and Imperial are connected by 20,900 ft. of 27-in. sewer line, which enters, at Imperial, a 33-in. line, continuing 25,680 ft. to the end. It is a single course, brick sewer, with a grade of 0.75 per 1,000, giving a maximum velocity of 2½ ft. per sec. when flowing half full. Manholes are 1,000 ft. apart and the sewer depth varies from 10 to 30 ft. Except for a little ground water near Imperial, the sewer is in dry, compact silt. Normal fluctuations in the flow line vary from 0.2 to 0.4 of the sewer's diameter. The average time of sewage travel from El Centro to the end of the outfall sewer is about 6¾ hr. The cost of the outfall was $206,000, on which the bonds extend from 1915 to 1955.

Sewage clarification works include a battery of Imhoff tanks, somewhat deficient in sludge capacity, from which the effluent enters a concrete sump discharging into a concrete pipe line and then a wooden flume leading to the New River.

Specifications for brick mortar called for one part cement, two parts sand thoroughly mixed, fresh and dry, in a watertight box, and sufficient water to give proper consistency. Concrete was made from a 1:2:4 mix, with each ingredient accurately measured, enough water to make it mushy, and tamped to flush water to the surface. All construction was under excellent supervision. Inspection showed that the mortar below the flow line, when tapped, rang clear and hard, and the concrete appeared dense and well made. There can be no alibi charging poor materials or improper construction.

SWELLING OF DISINGTEGRATED MORTAR IN MANHOLE JOINT IN OUTFALL SEWER

Odor Complaints—Records of the State Board of Health reveal that odors emanated from the manholes and Imhoff tanks shortly after completion. Complaints continued insistently up to 1922 when a first casual inspection was made. It was found that three houses were located within two miles of the Imhoff tanks; several manholes were giving off odors along the Brawley-El Centro highway; and the maximum range of odors affecting residents and travelers was about two miles. The odors were particularly nauseating and gagging—quite different from the normal odors of average domestic sewage. Further investigation from the nuisance standpoint led to a study of the deterioration of the sewer structure.

Deterioration—Inspection of the sewer instantly revealed characteristic growths of Beggiatoa and Sphaerotilus, forming mats at the water line, and sludge mixed with silt in the bottom, 4 to 6 in. deep. Periodically large masses loosened and tended to overload the Imhoff tanks with added suspended solids. These organisms, pointed to the possibility that mineral sulphates were being broken down to produce enormous volumes of hydrogen sulphide or related compounds.

Examination of manholes revealed heavy yellowish-white and yellow deposits on the sides, manhole steps

completely corroded, and softened brick mortar exuded ¾ to 1 in. from the joints. The joints of the brick sewer above the water line at the manholes showed that disintegration had penetrated 1½ in., whereas between manholes it varied from ½ to 1 in. Below the water line, the mortar was hard and untouched. The crown line was less affected than the 0.4 depth. A few bricks in the crown of the sewer showed evidence of longitudinal spalling, to a depth of ¼ to ½ in.

Distintegration of concrete at the Imhoff tanks was noticed only at the effluent sump where spray kept portions of the wall alternately wet and dry. In places, the concrete had fallen away to a depth of 2 in. A short section of concrete pipe beyond the effluent sump had corroded at the water line almost to failure.

Remedial Measures—While tests were not made to determine the specific types of organisms present, apparently working in the sulphur cycle, it was assumed that some organisms reduced the mineral sulphates to hydrogen sulphide, and that this gas accumulated in droplets above the water line, in which other organisms

DISINTEGRATION OF CONCRETE IN EFFLUENT SUMP OF EL CENTRO-IMPERIAL IMHOFF TANK

Damage limited to concrete alternately wet and dry by means of effluent spray. Short section of concrete pipe beyond sump damaged almost to failure. No disintegration of tank noticed.

oxidized the sulphur to weak sulphurous acid. The weak acid then oxidized catalytically, or by other organisms, in time concentrated through evaporation, finally attacking the lime in the cement, forming gypsum. This substance is soft, has no strength and occupies a greater volume than its equivalent in lime, causing mortar to swell out of its joints, or concrete to spall. The initial and final stages are well established, even though the above theory is not rigorously supported by the data at hand.

The first experiments aimed at eliminating Beggiatoa, through the application of copper sulphate. For a three-weeks period, this was added at the rate of 50 lb. per m.g., from a gunny sack hung in the sewage at a manhole near the upper end of the outfall. The following tabulations show the results of this treatment so far as reduction in mineral sulphates was concerned:

	Mineral Sulphate Determinations P.P.M.	
	Before Treatment May 16, 1922	After Treatment June 19, 1922
El Centre (start)	270	88
One mile below	240	
Two miles below	200	
Imperial	220	88
Halfway	210	94
Tank inlet	115	96
Tank outlet	120	86

Although the mineral sulphates in the water supply had materially lowered, the great relative reduction at the start had been completely controlled by the copper sulphate treatment. On May 16, 1922, over 575 lb. of hydrogen sulphide gas was being produced daily from mineral sulphates alone. So satisfactory was this method that portions of the lateral sewer system were similarly treated. However, expense of chemicals and maintenance, together with uncertainty about future protection of the line, led to abandoning this form of treatment.

Disintegration at the Imhoff tank was stopped by eliminating the effluent sump and carrying the effluent direct to the river by means of an air-sealed cast-iron line.

The second experiment was that of flushing the outfall every two weeks by temporarily backing up the sewage at each successive manhole. The following table gives results before and after six months of such treatment:

	Mineral Sulphate Determinations P.P.M.		
	Before Treatment Jan. 8, 1925	After Treatment June 11 to July 9, 1925	
El Centro	330	...	...
1½ miles below	310	45	125
3 miles below Imperial	225	11	125
Tank inlet	160	11	80
Tank outlet	155	15	48

In January, 1925, the hydrogen sulphide production from mineral sulphates reached 650 lb. per m.g. This is equivalent to about 1,000 cu.ft. of gas per day, which could be detected when mixed with five billion cubic feet of air, thus easily accounting for the great distance the odors were carried.

Flushing in this manner failed, due no doubt to inability to secure a sufficient scouring velocity. It undoubtedly checked the deteriorating action by washing out the full bore of the sewer before evaporation and concentration could further attack the mortar above the normal water line. Odors, however, were not eliminated.

To control both odors and deterioration, brick walls with 24-in. drainage gates are now being constructed in the center of the manholes, to keep the sewage backed up in the full bore. Fortunately, the New River is a saline drainage channel, carrying large volumes of swift flowing, silt-laden water to the Salton Sea, and no nuisance will result even if it is necessary to bypass the Imhoff tanks.

The method adopted to control odors will incidentally save a structure for which there is still outstanding $150,000 in bonds.

Old Iron Viaduct Converted to Reinforced-Concrete Structure

In Constructing Beck Memorial Bridge at Lynchburg, Va., Use of Old Structure Secured Economy and Minimized Interruption of Traffic—Flexible Expansion Walls—Method of Cutting Old Steel at Joints

By John F. Hough

Structural and Technical Bureau, Portland Cement Association, Chicago; formerly Resident Engineer, Allen J. Saville, Inc., Richmond, Va.

IN CONSTRUCTING a new street viaduct over the valley of Blackwater Creek, in Lynchburg, Va., during the past year, notable economy and other advantages were realized by retaining the old wrought-iron viaduct which occupied the site, and constructing the new viaduct by embedding the old structure in the concrete of the new. The old ironwork was used in the new structure at its full reinforcing value, and at the same time it supported forms and permitted traffic to be maintained during a large part of the construction. The cost of a new viaduct of reinforced concrete, if built after removing the old viaduct, would have been in the neighborhood of $800,000, while the structure actually built cost less than $500,000.

In 1892 the iron viaduct was built across the valley by a realty company. Some years later it was acquired by the city. The crossing is 908 ft. wide, and roadway level is at a maximum height of 132 ft. above valley bottom. Most of the structure consisted of 62-ft. truss spans, carrying a wooden floor on transverse plate girders, cantilevering out to carry sidewalks. Increasing weights of traffic progressively exceeded the capacity of the bridge until, in 1925, it became imperative to consider replacing the structure.

Careful engineering studies were made before deciding on the method of reconstruction. The proposal to use the old structure as a core or nucleus for the new viaduct was soon recognized as most desirable, since it permitted maintaining all traffic during part of the time of construction and pedestrian traffic during the whole time, which was a decided public advantage in avoiding long detours.

Near the south end of the viaduct, the tracks of the Norfolk & Western Ry. are crossed, and here the spans of the old structure were on a skew and varied in length. These factors presented such complications with respect to embedment of the old structure in the new that it was decided to remove this part of the ironwork and replace it by two arch spans of 132 ft. each. The remainder of the structure, however, carries out the plan of embedment in all respects.

The general design is clearly shown by the drawings in Fig. 3, which include elevations of the old and the new structures. The old viaduct was supported by towers alternating with rocker bents. The double bents were converted into reinforced-concrete hollow piers 34 ft. wide, and the single bents were incased so as to form concrete rockers. The old trusses are incased in concrete to form reinforced-concrete girders 17 ft. deep, 2 ft. wide, and 60 ft. long. A concrete floorbeam and stringer system carries a 5-in. floor slab on which is laid a pavement of 2½-in. brick with bituminous filler, on sand cushion. The middle four stringers carry a double-track street railway, the floor slab being depressed 4 in. on the width of each track to receive the rails.

Expansion was provided for by separating the end wall of the tower from the side wall down to base level, so that the end wall constitutes a flexible rocker support for the girders. The longitudinal members of the old towers were, of course, cut at these joints after the incasement was complete. A slight change in the expansion arrangement occurs at the arch spans, where the arch ribs are continuous with the piers but the floor system requires expansion. Here the end walls of the piers are full, instead of broken by opening as in the case of the other piers, and the expansion joint is located in the end wall rather than in the side wall. This arrangement is brought out by the plan of expansion joint arrangement, in Fig. 5. The floor has expansion joints directly over the pier expansion joints.

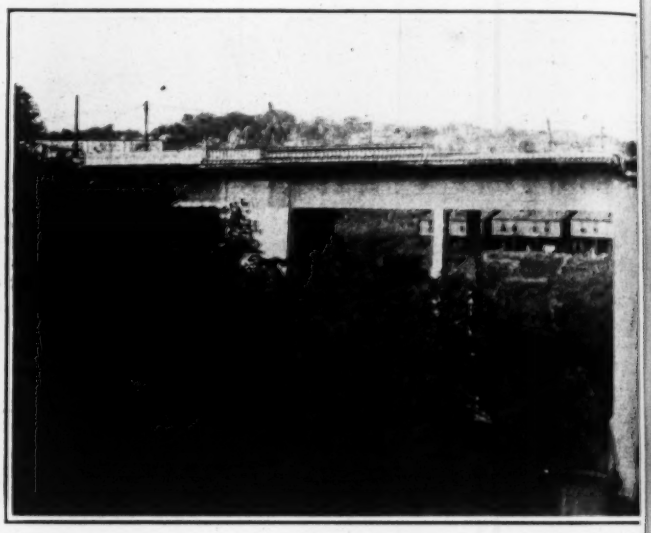


FIG. 1—BUILDING A NEW VIADUCT AT

In the old structure all material except the eyebars (which were steel) was wrought iron. In proportioning the supplementary reinforcement, the old material was rated at a ratio of moduli of elasticity of 10, while the added reinforcing steel was rated at 15.

Features of Construction Work—The construction work was marked by special features of interest in the foundation construction, the provision for supporting the main girder forms from the deck of the structure itself, and the method of maintaining pedestrian traffic across the south part of the bridge while the arches were being built.

The old pedestals, built of stone, with a base dimension of 8x8 ft., were supported generally on rock, but six of them proved to be founded on red clay. While the latter material had carried the load for 35 years with little or no settlement, it was necessary to carry the footings of the new viaduct to rock.

In underpinning the six clay footings down to bed-

rock (in several cases as much as 14 ft. below the base of the old masonry), pits 4x15 ft. were dug on either side of a pedestal and filled with concrete up to the level of the column bedplate. Two beams were then placed on these concrete supports, one on each side of the steel column, engaging bracket plates riveted to the column in such a way as to form knife-edge bearings on the beams. By jacking under one end of the beam the column load was completely taken up, the column with the base plate and capstone raised ¼ in. off the masonry, and the masonry then removed. Excavation was continued beyond the old footing level down to bedrock, and the new pedestal was poured in this pit. The concrete was carried up to 12 in. above the base of the old column, embedding the base plate and capstone; old rail was set in the concrete under the capstone to assist in distributing the load throughout the area of the new pedestal. The jacks were removed after 10 days and work started on another pedestal.

During these operations traffic was never interrupted, but slow orders were in force.

LYNCHBURG BY ENCASING OLD WROUGHT-IRON STRUCTURE IN CONCRETE

A special condition was encountered under the pedestals of the highest pier. When the side pits were carried to a depth of about 3 ft. below the capstone, the ground was found to be very soggy, and thereafter water came in faster than a one-man pump could keep it out. It turned out that the old stone footing rested on a mat of 8x8-in. timbers, under which there was nothing but pure muck for a depth of 16 ft. This point was at one time the bed of a stream that had been diverted into a sewer when the bridge was built, but a leak in the sewer kept the soil in the old stream course saturated. It was necessary to use steel sheeting to complete the excavation.

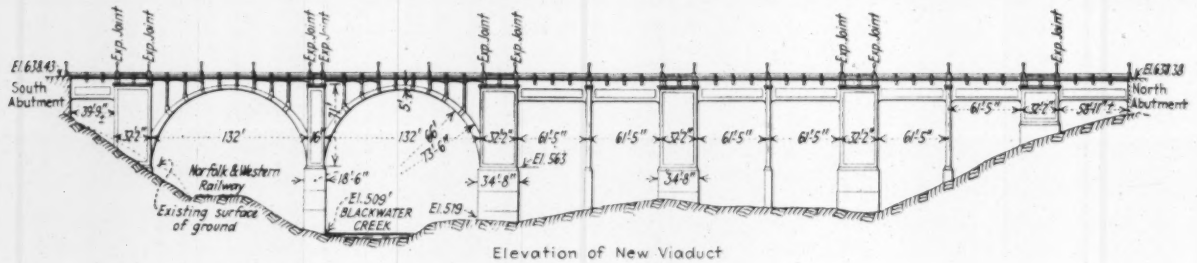
Even more peculiar conditions were encountered at the third bent from the south end, close to the creek channel. The old pedestals extended down to rock, 16 ft. below stream bed, but the rock surface, which sloped at about 47 deg. below the horizontal, had not been stepped or leveled off. It appeared also that the footing had been started 18 in. off true position, and the error corrected at a height of 6 ft. above rock by simply shifting the masonry over the corresponding amount. It is probable that the footing was kept from sliding down the rock slope only by the resistance of the earth bank between the pedestal and the creek, a bank only 10 ft. wide at the time the condition was discovered, as the creek had gradually been cutting the earth away. As soon as the condition of the footing was discovered, vehicle traffic on the bridge was stopped entirely until the footing of the new pier had been constructed.

FIG. 2—COLUMN SUPPORT DURING UNDERPINNING

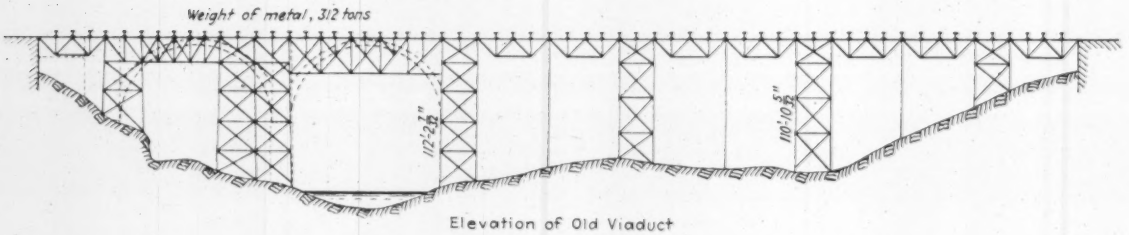
Concreting of the rocker bents and piers was done in sliding forms, making pours 8½ ft. high. This method of construction was particularly convenient because the old towers afforded something to tie to. At the top of each pour, a triangular bead was used to prevent making an unsightly joint.

Suspending Girder Forms—The main girders were so high from the ground that support of forms by timber shoring from below would have been very costly. The plan of suspending the forms from trusses over the bridge floor was then devised, and in its application proved highly successful.

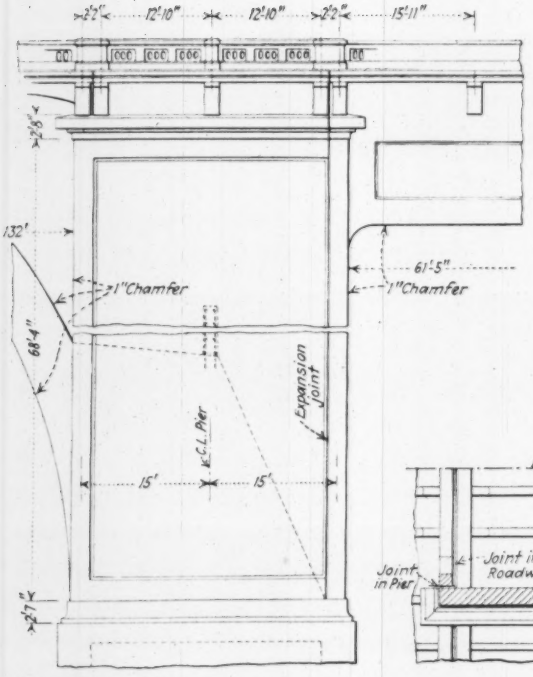
Four steel trusses were designed and built, two per girder, permitting the simultaneous pouring of two adjacent girders, as required by the specifications. These trusses were fabricated on the bridge floor, lying flat, and were then set upright and the girder forms suspended from them by rods. With each girder, the



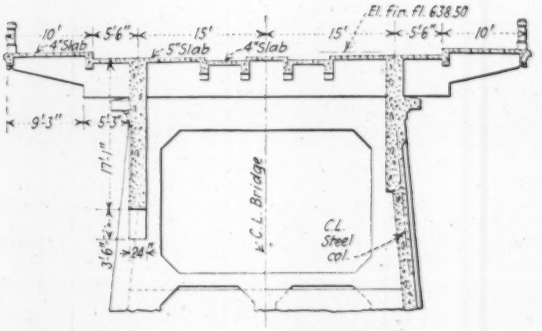
Elevation of New Viaduct



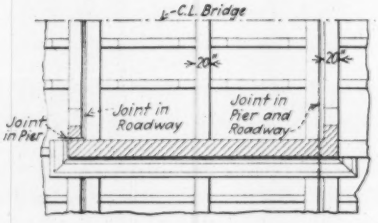
Elevation of Old Viaduct



Pier at Junction of Arch and Girder



Cross Section of Girder Span Cross Section of Pier Span



Pier Plan Showing Expansion Joints (Looking Up)

FIG. 3—GENERAL DRAWINGS OF OLD AND NEW VIADUCTS, LYNCHBURG, VA.

upper section of the expansion wall at one end of the girder span was poured.

After three weeks, the old steel members passing across the expansion joint were cut with an oxyacetylene torch, and the girder forms were then lowered and the rods removed. This released the trusses, which were thereupon moved forward to the next span.

Cutting Steel at Joints—The joint separating the expansion-wall section of each pier from the main part of the pier extended down as far as the base of the pier, and thus crossed a number of struts and diagonals of the tower bracing. It was necessary to cut these members in order to permit the flexible expansion walls to function, but the cutting could not be done until after the pier was concreted, since the old viaduct columns were not stiff enough to stand as unsupported columns on their full height.

The method sketched in Fig. 4 was used to permit cutting the members after concreting was completed. The expansion joint was formed by a 1-in. board. On either side of this board the members to be cut later were surrounded by a lump of plaster of paris. After concreting and form removal, this plaster of paris was

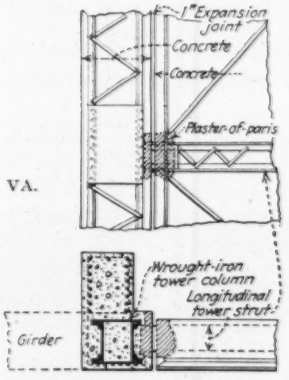


FIG. 4—PROVISION FOR CUTTING STEEL AT JOINTS

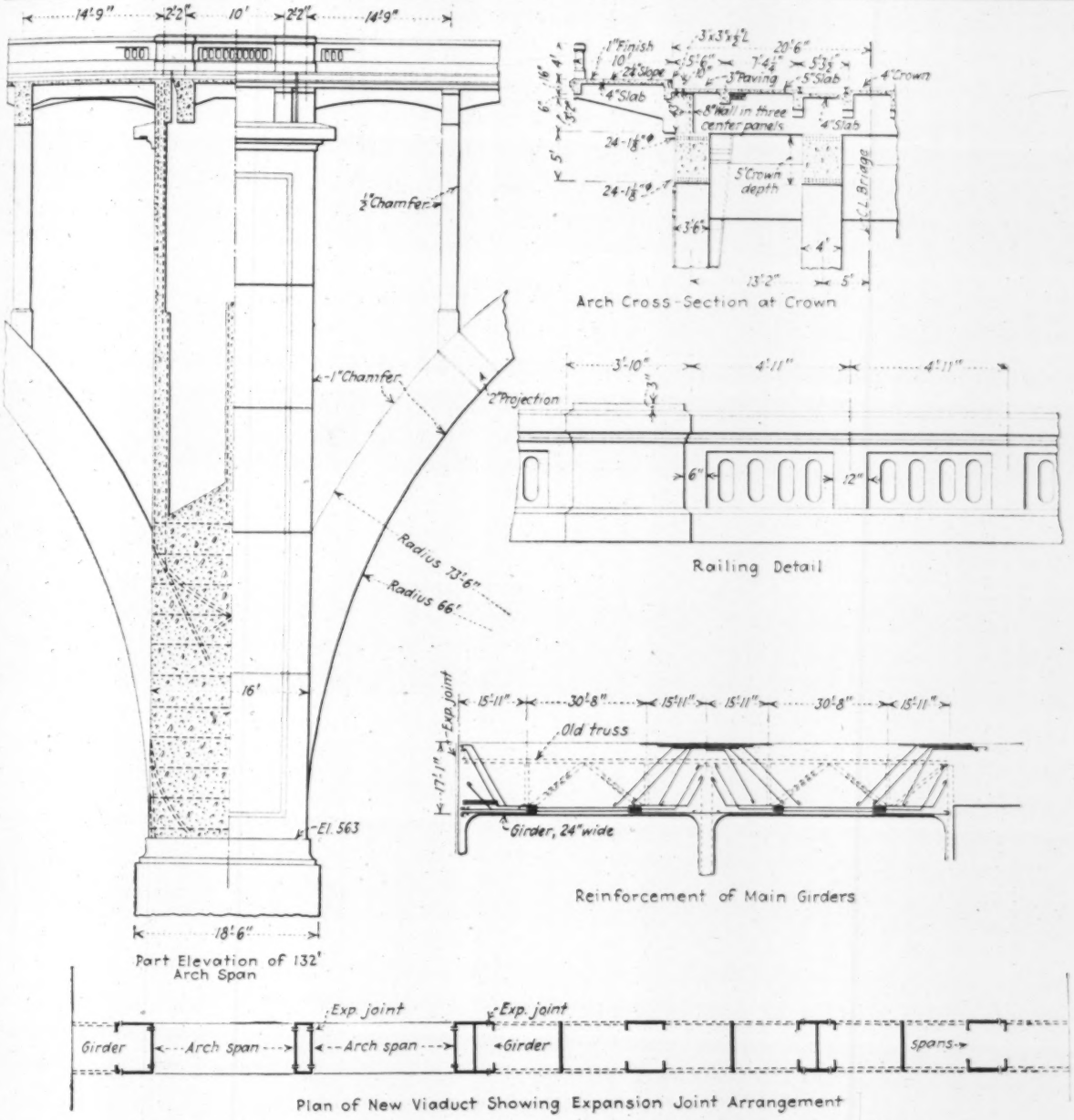


FIG. 5—GIRDER, ARCH AND RAILING DETAILS, AND EXPANSION JOINT ARRANGEMENT

dug out, making a pocket large enough to permit burning off the members back of the finished concrete face. These pockets were finally filled and plastered.

All the concrete above the footings (which were 1:3:6) was of 1:2:4 mixture, with crushed limestone as coarse aggregate. These proportions, however, gave too coarse and harsh a consistency, and the concrete showed a 28-day strength slightly below 2,000 lb. The mix was changed to a 1:2½:3½ mix, which gave proper workability and a strength well over 2,000 lb.

Concreting Plant—A central mixing plant was located under the bridge about at the middle of its length. A one-way tower elevator ran to a point well above the bridge floor. The plant comprised a 1-yd. mixer with a Blaw-Knox inundator for the sand, and was served by a railroad spur, a clamshell derrick handling aggregate to storage pile, and a belt conveyor to carry cement from the storage shed to the mixing platform.

Concreting within 150 ft. of the tower was done by direct chuting, while for work at a greater distance the concrete was dumped into cars running on a narrow-gage track on the bridge floor and thence taken to floor hoppers chuting direct into the forms. Concrete for the floor was handled from the tower by buggies.

With the inundation method, and with accurate measuring of the aggregate, consistent results in concrete quality were obtained. Cylinders broken at the age of six months showed not less than 3,000 lb. crushing strength.

Arch Construction—Each of the two large arch spans consists of four ribs. Self-supporting steel centering was used to carry the rib forms. Corresponding ribs in the two spans were poured simultaneously. They were cast in blocks or voussoirs in specified order, allowed to set a week or more before the keys between them were poured. The arch ribs are 5 ft. deep at the

crown and 6½ ft. at the springing line; the outer ribs are 3½ ft. wide and the inner ribs 4 ft. wide.

In all the concrete containing any of the structural members of the old bridge, a 5 per cent lime admixture was used. This assisted in giving a good consistency, and assured excellent bond with the old metal.

Maintaining Pedestrian Traffic—Traffic maintenance presented a difficulty in the southern third of the bridge, over the arch spans. Here all of the structure except the floorbeams had to be removed. The procedure followed was to pour first the two middle arch ribs, in order to support the old floorbeams, and thereafter burn away the trusses of the old bridge. The floorbeams, however, had first to be shifted in order to come over the posts on the arch ribs. To keep part of the floor open for pedestrian traffic while shifting the floorbeams, the continuous double-channel members that had supported the car tracks were utilized. These members were placed over the two completed arch ribs, and a walkway was constructed on them. Turning pedestrian traffic over this walkway gave room for moving the floorbeams to their new position, one at a time. The posts over the two middle arches were then poured so as to give the floorbeams bearing, and the old trusses taken down.

Quantities and Personnel — Construction of this bridge involved 14,400 cu.yd. of Class A concrete, 2,500 cu.yd. of Class B concrete, 650 tons of reinforcing steel ranging from ½-in. round to 1¼-in. square, and 7,000 yd. of excavation, of which 3,000 yd. was rock.

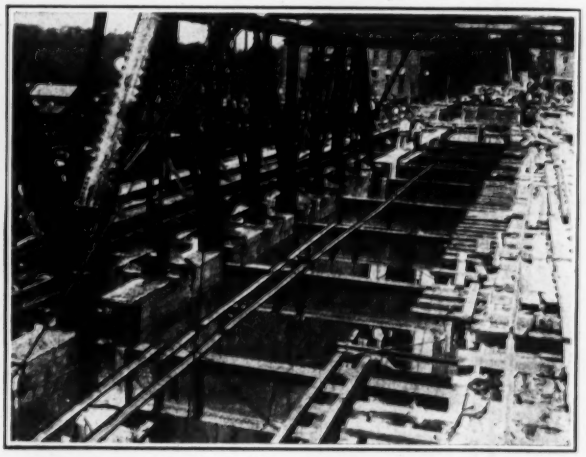
The bridge was designed by Allen J. Saville, Inc., of Richmond, in consultation with A. C. Janni, and Philip Aylett, of New York City. The Whiting-Turner Construction Co., of Baltimore, carried out the work, under a contract let in October, 1925. L. N. Phillipy was superintendent for the contractor, and the writer was resident engineer for the designing engineers and the city. Work was begun in November, 1925, and was completed in August, 1926, within the contract period of 235 working days.

The old bridge was called the Rivermont viaduct. In memory of Edward A. Beck, former city manager of Lynchburg, who first conceived the idea of converting the old bridge into a reinforced-concrete structure, but died a few days after the contract was let, its name has been changed to Beck Memorial Bridge.

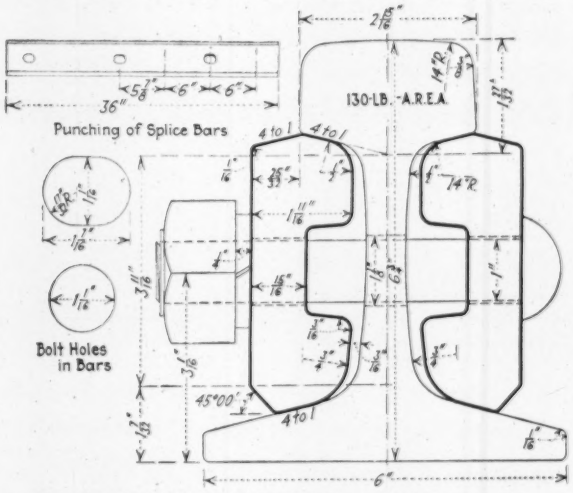
C., M. & St. P. Ry. Adopts Fish-Plate Splice for 130-Lb. Rails

IN adopting a rail weighing 130 lb. per yard, A.R.E.A. section, of which 50 miles are to be laid this year, the Chicago, Milwaukee & St. Paul Ry. has adopted also a new form of heavy fish-plate splice, instead of the angle-bar splice which is so generally used. This is another indication of a tendency towards the use of plain or fish-plate type of splice bar, which is seen in several forms of modern rail joints. On the Chicago, Milwaukee & St. Paul Ry. the heaviest rails used heretofore have been of 100-lb. section, spliced with angle bars and various types of patented joints.

The bars are of channel section, ⅞ in. thick in the web, with heavy ribs. They weigh about 20 lb. per yard, or 60 lb. for each 36-in. bar. The six bolt holes are spaced 6 in. c. to c., except that for the two middle holes the spacing is 5¾ in. In accordance with usual modern practice the bolts are placed with heads and nuts alternating on each side of the rail, so that the bolt holes in the bars are alternately circular and oval, 1⅛ in. in diameter and 1⅛x1⅞x in. All bolt holes in the rails are circular, 1¼ in. in diameter. The 1-in. bolts are 6¼ in. long, wth oval necks and button heads.



FIGS. 6 (LEFT) AND 7 (RIGHT)—FORMS FOR MAIN GIRDER AND TRUSSES ON DECK FOR SUPPORTING GIRDER FORMS



NEW RAIL AND SPLICE BARS: C., M. & ST. P. RY.

Concrete Mix Designing on an Oklahoma Dam

How Water-Cement Ratio Method of Proportioning Worked Out in Building the Lugert Dam—Conclusions and Recommendations

By Webster L. Benham
Consulting Engineer, Kansas City, Mo.

In the construction of the Lugert dam in Oklahoma the concrete was specified by strength, and the proportions worked out from tests of the available aggregate according to the method proposed by the Portland Cement Association. The following account of the results of the method is taken from a paper presented to the Kansas City Engineers Club.

THE LUGERT dam which is being built about 18 miles north of Altus, Okla., to impound a water supply in the North Fork of the Red River, is of the Ambursen type, about 55 ft. high above bedrock, having a spillway 454 ft. long and a non-overflow length of 114 ft. It is curved in plan on account of foundation conditions, but is not designed for arch action. Since the walls are comparatively thick and have little steel concrete placing is not difficult, but it offers more resistance in the deck and apron, with a thickness of 17 to 37½ in. and a close spacing of reinforcement.

A general view of the work in progress is given in Fig. 1, while a plan of the construction plant is shown in Fig. 2. At the railroad siding, the sand and crushed rock are unloaded by a crawler crane with clamshell bucket, placing the aggregates either in stock piles or in bins built over a narrow-gage track, on which two six-car trains operate between the bins and concrete mixer. On each track are two boxes of 37 cu.ft. capacity, with bottom doors for dumping, and with slats nailed inside to measure the load. This crude method of measuring caused most of the difficulty in the maintenance of a uniform quality of concrete, as the material will not assume the same slope each time, but is affected by the manner in which it leaves the chute, a fine continual stream piling up with a steeper slope than large masses flowing intermittently. The result is too much or too little material, as the workman invariably allows the crest of the material to fill to the same point each time. This unsatisfactory loading was remedied to some extent by placing another man to level the materials to the slats. Batch boxes should be provided so that the exact volume of aggregate can be held uniform.

The loaded train is moved to the cement shed, and then to the mixer. The steam-operated mixer has a 40-gal. water tank above the drum. A movable discharge pipe within the tank controls the amount of water discharged, and checks by measuring and computation have shown this amount to be closely accurate. The water is passed through a boiler during freezing weather. From the mixer the concrete drops into 1½-yd. buckets. The bucket is transferred on a narrow-gage track to a point under the cableway, where it is hoisted and carried to a truck on a track over the form. It may also be hoisted up a 70-ft. tower and dumped into a hopper, from which the concrete is carried to the form by a steel chute, this method, Fig. 3, being necessary to reach portions of the dam not directly under the cableway.

This is the first job on which we have specified the water-cement ratio, and we are not disheartened because all features have not been entirely satisfactory. Our specifications, patterned after those used on the Portland Cement Association Building, at Chicago, included the following:

Attention is called to the manner in which allowance must be made for batch-to-batch fluctuations in water content. Instead of specifying the average water-cement ratio desired with a definite tolerance, the maximum permissible

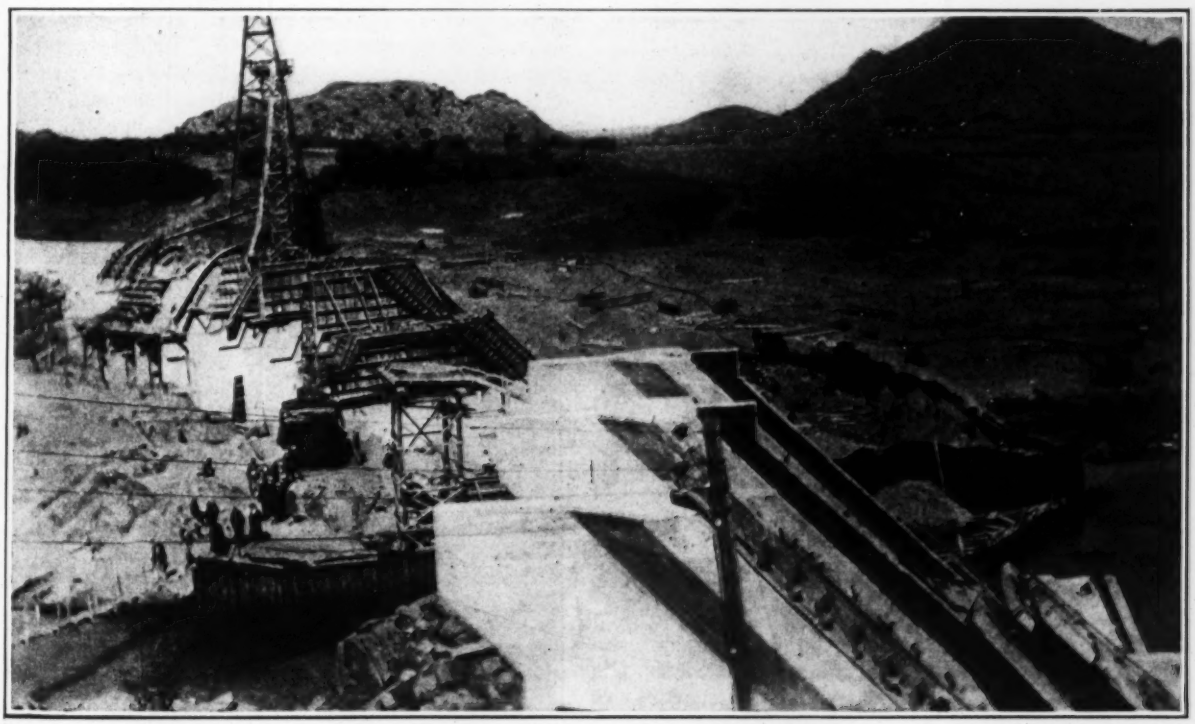


FIG. 1—BUILDING THE LUGERT DAM, OKLAHOMA
Cableway tower and concreting tower at farther end. View looking north from south abutment cofferdam.

values have been given and this will enable the contractor to obtain increased economy as his methods of controlling the water are perfected, as the smaller the variation, the closer the maximum permissible limits can be approximated by the average water content. Determinations of the moisture content in the aggregate from time to time will be necessary in order that the water content will be at all times within the water-cement ratio specified. The frequency with which moisture content determinations will be required and the consequent annoyance of making changes in the mix will depend entirely upon the care used in controlling the grading and uniformity of measurement and the mositure content in the aggregates. A water-storage and water-measuring device shall be provided.

Two classes of concrete are specified, for 1,500-lb. and 2,400-lb. minimum strength at 28 days. The former calls for a minimum water content of 7.5 gal. per sack of cement or a water ratio of 1.00, and the latter of 6 gal. per sack or a water ratio of 0.80. The 1,500-lb. concrete is for buttresses, footings, sluiceway spills, sluiceways, cutoffs and piers; the 2,400-lb. concrete is for the deck, crest, apron, bucket, beams, walkways, platforms, intake and roadway.

Field Apparatus.—The field testing apparatus and equipment, Fig. 4, consist of: A set of sieves containing one each of 48-, 14,- 4-mesh, $\frac{3}{8}$-, $1\frac{1}{2}$- and 3-in. mesh; a measuring can $2\frac{7}{8}$ in. in diameter and 10 in. high, and another $5\frac{3}{4}$ x 11 in., with covers; a slump cone, 4 in. to 8 in. in diameter; cylinder molds of galvanized iron, 6 x 12 in.; a $\frac{3}{8}$-in. rod with bullet-shaped end; two pieces

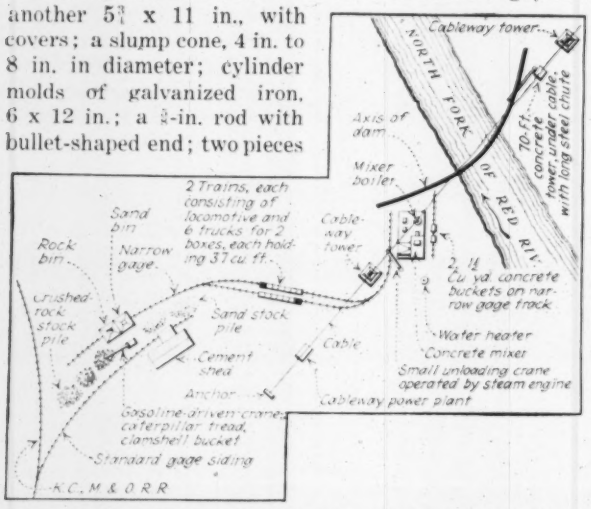


FIG. 2—CONSTRUCTION PLANT AT LUGERT DAM

of canvas 36 in. square; a trowel with rounded end; a torsion balance ranging from 0.1 to 1,010 grams; two baking pans about 10 x 14 in. and $2\frac{1}{2}$ in. deep; quart and pint tin measures; a piece of plate glass $\frac{1}{4}$ in. thick; tin plates 7 x 7 in.; a 3 per cent stock solution of sodium-hydroxide; several 12-oz. graduated bottles; a folding rule graduated in tenths and hundredths of a foot, and a $2\frac{1}{2}$-gal. tin pail. This apparatus is housed in a small building and the torsion balance is mounted on a platform and pedestal, independent of the floor and building. We would recommend that the full set of sieves be procured, to include the 100-, 28-, and 8-mesh, in order that any fineness modulus may be determined directly without interpolation. These should be also a 200-lb. scale provided, sensitive to $\frac{1}{4}$ lb., a Fahrenheit thermometer, a small oil stove, and a heavy funnel 3 in. to 8 in. in diameter, for filling the slump cone and test cylinders.

For sampling, a 50- to 75-lb. bag of coarse aggregate from the chute at the bin was poured into a conical pile on the canvas mat and quartered. Each quarter was then weighed, dried in one of the flat pans, again weighed and moisture content computed. After this the

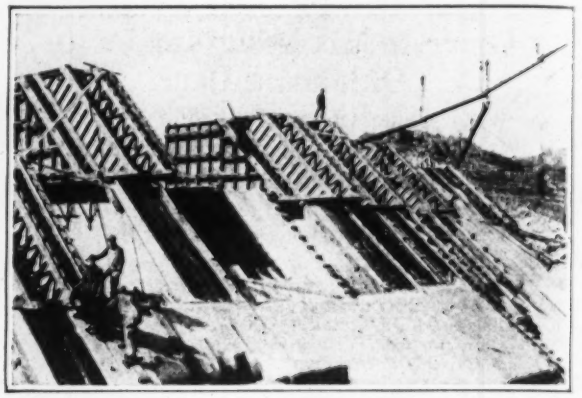


FIG. 3—CHUTING CONCRETE FOR DAM

sieve analysis was made. The $\frac{3}{4}$-in. and coarser materials were first taken out and the analysis started with the 48-mesh, this being the finest sieve of the field set. The amount of material passing the respective sieves was weighed to compute percentages. The results were:

Grading, $\frac{3}{4}$ to 3-in., bulking of rock	10	per cent
Fineness modulus	7.97	
Weight per cubic foot, loose	95	lb.
Weight per cubic foot, dry and rodded	100	lb.
Weight of sample; loose, damp	4,133.1	grams
Weight of sample; loose, dry	4,107.0	"
Weight of moisture	26.1	"
Per cent of moisture	0.6	

Concrete Mix—For 1,500-lb. concrete with a 5-in. slump, the nominal mix would be 1:2.7:5.1, and due to 23 per cent bulking of the sand and 8 per cent of the rock, the field mix 1:3.1:5.7 was determined. But the test specimens failed to meet the requirements on account of lack of control of the aggregate, giving too much fine material. Further the amount of water was too high. One hand-mixed sample of 1:4:5½, using 6 gal. of water, with 4-in. slump, tested 1,350 lb. at 28 days; another of 1:3.1:5.7, using 8.8 gal., including water absorbed by aggregates, in 14 days tested over 50 per cent of the 1,500 lb. required. Others tested around 1,050 lb. at 28 days. The mix has now been changed to 1:3:5, with 6.8 gal. per bag of cement, including water absorbed by aggregates. The slump varies from 5 to 6 in.

We are using Celite, 3 per cent of weight of cement, in all of the concrete. As this material has a high rate of absorption it does not conflict with the water-cement ratio theory but works in harmony with it, as the con-

FIG. 4—CONCRETE TESTING EQUIPMENT

crete can be handled and placed drier and the excess water absorbed. Our test shows the absorption for this to be about 200 per cent by weight. The computation for the water content per bag of cement, for the 1:3:5 concrete of 1,500-lb. strength at 28 days, is:

		Gal.
Maximum water permissible		7.5
Absorption of sand	1.8	
Absorption of rock	0.2	
Absorption of Celite	0.7	2.7
Net water, exclusive of absorption by aggregates		4.8

At the mixer 6.8 gal. are added. Deducting 2.7 gives 4.1 gal., which should meet the requirements. In like manner we arrived at the field mix for the 2,400-lb. concrete, namely, 1:1.3:3.3 with a slump of 5½ to 6 in. and 5.8 gal. of water added at the mixer. All of these cylinders have tested higher than the requirements, except one specimen, which apparently had frozen. Test specimens are prepared in accordance with standard methods. The piece of glass is used for a base and the top is completed with a trowel, using neat cement placed after the concrete has settled but not thoroughly set. The specimens are packed in damp sawdust and shipped to the testing laboratory of the engineering school of the University of Oklahoma. All work is being done under supervision of H. W. Nighswonger, resident engineer.

Conclusions and Recommendations — While certain features relative to control of the ingredients of the concrete have not worked out satisfactorily, we believe the water-cement ratio is the logical and correct specification for concrete. Considerable education is needed among contractors and engineers as to its value and significance. Crusher plants should be equipped to furnish uniform aggregates and the contractor should provide means of positive control of crushed stone and sand. An inundator also should be specified.

How to Tell a Good Weld by Surface Inspection

By Lewis E. Moore
Structural Engineer, Boston

THE structural engineer distrusts welds largely because of prejudice. He knows that the old fashioned blacksmith's weld was wholly dependent for its success on the skill of the individual, and that failures of these welds were very common. Those who, like the writer, have occasionally tried to make them and have met with reasonably consistent failure distrust them as a natural result.

But the electric-arc weld is a very different affair from the old blacksmith's weld. It is a fusion of the metal rather than a weld in the true sense of the term. In fact, if the term "fusion" rather than "weld" had been adopted in the beginning, the process would probably not have so much prejudice to combat.

It is time for the structural engineer to forget his prejudice and look at fusion welding with an open mind. As a rule he believes more strongly in rivets than welds because he feels that at any rate the metal is pinned together—and also because of the subconscious prejudice referred to. He thinks that he can tell whether a rivet is good or not by looking at the head and testing it with a hammer (how many really can tell?). The idea that it is a pin may give him a false sense of security. The writer has seen beautiful rivet heads that he happened to know covered a multitude of sins.

How To Recognize Good Welds—The structural engineer would have more confidence in welds if he knew how to tell surely a good weld from a poor one by inspection and that without going through any elaborate psycho-analysis of the man who made the weld, or indeed without knowing who made it at all. Fortunately, there are three simple rules that will indicate whether or not a weld is good. They are:

(1) Surfaces must be "tacked" together. With hand welding the arc should be swung from side to side, forming half-moon beads which look somewhat like heavy thread in a seam in leather. In machine welding these half-moons are absent, but a very little experience plus intelligent observation will show whether the metal has flowed over both surfaces enough to establish good contact on each one.

(2) Color indicates quality. If the bead turns red and rusty looking within twenty minutes or so after the weld is completed, it indicates that the heat was too great and that the metal is burned. If the metal stays steel color, it has not been overheated.

(3) Penetration, or depth of weld, which is obviously necessary to obtain through uniting of the parts, is indicated by absence of spattering of metal. The presence of "spattered" metal shows lack of depth and consequently probable weakness. When the bead has an undercut edge, that is, looks like a drop of solder on the surface, the fusion is insufficient. When the surface of the bead adjacent to the junction is curved in the other direction and looks saucer-shaped, the fusion is complete.

Ductility and the Shielded Arc—The most serious objection to welds is the great reduction in ductility of the welded material as compared to the parent metal. The ordinary weld has a ductility of about 5 per cent, as against 25 per cent or so in the parent metal. The non-welded area may be from 11 to 20 per cent. The non-welded areas form excellent places for the starting of cracks. This loss of ductility is undesirable; one would hesitate, for instance, to make two beams continuous over a support (where the bending moment may be a maximum) by uniting them by a material which is less ductile than the parent material in the beams.

Fortunately, this problem of the reduction in ductility in the parent metal appears to have been solved by the use of the so-called shielded arc, which is an arc operating in a bath of hydrogen gas. The welds produced by this method have a ductility equal to that of the parent metal and there is no non-welded area. This method has given wonderful results in the laboratory and shops. Using hydrogen gas sounds formidable and expensive. Actually it is much easier to obtain good welds by its use than by the use of the open arc. The expense is somewhat greater than for the open arc, but the results are far superior and more certain. The expense will probably be reduced as the methods of producing the hydrogen are improved. A considerable offset to the increased cost is the more rapid work that can be done.

In conclusion, the welding, or fusion, of structural steel has come to stay, and structural engineers may as well make up their minds to it, learn about it, and adopt it gradually as they familiarize themselves with it, its limitations, and its possibilities.

Engineering Literature

A Monthly Review of Books and a Listing of New Publications

A Comprehensive Treatise

REVIEWED BY F. A. ALLNER
General Superintendent Pennsylvania Water & Power Co., Baltimore, Md.

HYDRO-ELECTRIC HANDBOOK—By William P. Creager, Vice-President and Chief Engineer, The Power Corporation of New York, and Joel D. Justin, C.E., M. Am. Soc. C. E., Hydraulic Engineer, The U. G. I. Contracting Co., Philadelphia, Pa.; With the assistance of nine contributors. New York: John Wiley & Sons, Inc., London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. 897; with tables and 494 halftones and line cuts; 93 tables. $8.

The Hydro-Electric Handbook is a more comprehensive treatise on the subject than was ever attempted before in America. A critical reader cannot fail to be impressed by the ability of the two authors-in-chief and most of the contributors to write interestingly and authoritatively upon the majority of their subjects and by their wide knowledge of current published material. As indicated in their Preface the authors have set out to present a compendium of all phases of modern hydro-electric practice. Considering the many branches of general and specialized engineering that are embraced in this field, they have succeeded very well in gathering and placing in fairly orderly array an immense amount of material in a single volume of less than nine hundred pages.

On account of the merit of the book the reviewer has given several careful readings to most of the sections and has assigned certain special sections to engineering experts of his acquaintance for detailed consideration. The authors and publishers, therefore, should feel that the resulting criticisms are presented as constructive suggestions, opening up possibilities for still greater usefulness in future editions.

The great detail with which some of the subjects are treated is noteworthy. For example, the first ten chapters and Chapter 34 (taking up nearly one-fourth of the space), as also the chapters on Wood Stave Pipe, Water Hammer, and Hydraulic Turbines, are remarkably complete, at least as a catalog of facts.

In certain other sections of the book many pages are taken up with the development of formulas of questionable general application, and reprints are made of catalogue data (as pp. 729-37 on Wires and Cables) which can readily be found in a number of electrical handbooks. Yet these same or other chapters treated by the same author are obviously lacking in a critical digest of recent important trends in design and practice (grounded neutral, relay protection, research on lightning, ground wire, etc.), or of a clear set-up of the many "do's" and "don'ts" that frequently determine the question of success or failure.

Some of the topics that are treated with less detail and accuracy than the importance of the subject would warrant are the economic phases of hydro-electric developments, operating difficulties and means of coping with them, and cost of construction and operation, inter-relation of quality of service to the value of supply, etc. References to these subjects are scattered through many chapters, but they appear most frequently in the chapters on Transmission Lines, Investigations and Reports, and Operation of Hydro-Electric Properties.

The reader would obtain a better picture of the present and future economic place of hydro-development if more emphasis had been given to the function of hydro-power as part of a co-ordinated scheme of hydro and steam resources rather than as a justification in competition with steam supply, which is assumed to replace exactly the same style of power supply as available from the hydro source, applied to a more or less limited market. Such a situation may have existed some twenty years ago but now is rather the exception than the rule. Hydro and steam supplement each other and an exact competitive substitution can rarely take place. This general economic point of view has not been sufficiently emphasized.

In the specific example of a justification of a hydro development, Table 81, p. 804, and followed through in the subsequent analysis of financial set-ups, determination of value of site, comparison with steam costs, statements on costs of operation, etc., a number of obvious errors and inconsistencies have crept in. For example, Table 81 contemplates an investment of $500,000 for the auxiliary steam plant, the annual charges of which appear as 7 per cent on the investment ($35,000), plus the operating costs of 10 mills per kw.-hr. on 4,000,000 kw.-hr. ($40,000). Fixed charges, exclusive of interest, will probably be not less than 5 per cent, i.e. $25,000; this item apparently has been overlooked, and it is hardly conceivable that the author meant to include it in the operating charge of $40,000, as this would leave only $15,000 or less than 4 mills for operating costs proper. It is believed that even 10 mills per kw.-hr. is an unreasonably low figure for operation and maintenance, considering the small size of the plant and the probable irregularity of generation in the course of the year.

The subdivided items on cost of hydro operation proper appear too low and not consistent with the unit figures given by the same author on pp. 833 and 834.

The Probable Life table on p. 835 may be questioned in respect to several items: for example, wood pipe is given a life of 20 years and yet the very excellent chapter on this subject gives the impression of an appreciably longer average life. Racks are assumed to last 15 years, whereas fairly conclusive experience indicates a serviceability of at least twice as long under reasonable maintenance. All power house equipment is given a life of only 20 years and, considering the author's remarks on p. 834 about the part played by obsolescence, it would appear quite safe to expect a serviceable life at least 50 per cent greater.

On p. 838 maximum construction costs for steam plants (assuming them to refer to rated capacity and not to maximum output capacity under favorable conditions of temperature, power factor, etc.) are given too low, referring to 1925 cost index. The schematic set-up of annual charges for steam plants on p. 839, indicating 5 per cent for interest, 3 per cent for depreciation, 1½ per cent for taxes, and ½ per cent for insurance or a total of 10 per cent for steam investment, might give a misleading impression not contemplated by the authors

who selected the 10 per cent overall rate for convenience of calculation, and in most examples employ an overall rate of 12 per cent.

It is to be regretted that so little space (16 pp.) has been allotted to the important subject of operation of hydro-electric properties, including transmission lines, substations, load dispatching, reliability of service, management, power rates, etc. It is evident that the author's statements are drawn largely from experience with one particular system, composed of a multiplicity of small- and medium-sized hydro plants operated in co-ordination with several medium-sized steam plants, tied together by an extensive network of high-tension lines.

Neither in the chapter on operation nor elsewhere is sufficient mention made of the character of disturbances peculiar to hydro supply and usually not encountered on pure steam systems and the means employed to combat the effect of these disturbances on service. Various schemes employed successfully for minimizing the effect of sleet and lightning on transmission line service should have been mentioned, including special features of equipment and general design as well as methods of operation. References to the disturbing effect and possible remedies of ice and trash interferences are scattered through different chapters of the book, but a more complete picture could have been presented by treating all phases of the problem in a separate chapter. While the reader gets the impression that not enough space has been given to the discussion of hydro troubles and their remedies, conversely it is felt that not sufficient emphasis has been placed on the quick starting feature in medium and low head hydro plants equipped with pondage, i.e., the so-called a.c. storage battery service. This quick starting ability can be greatly enhanced by a suitable layout of auxiliary equipment, handy location of control valves, synchroscope, and other indicating devices, etc. A starting time of less than four minutes for a three-unit plant is given in the chapter on Operation, in a manner that gives the impression that this is a record performance. Much better performances are known to have been accomplished in some plants. In those chapters that deal with the valuation of a competitive source of supply, the economic features of stability of cost, protection of power supply against interruptions due to transportation tie-ups, strikes at the mines, etc., are not given the weight that they deserve.

The space filled by some of the electrical specifications, such as weights and dimensions (induction motors, direct-current generators, conduits, etc.), might better have been devoted to more important matters. For instance, design features of electrical and mechanical equipment aiming at safe practices in operation and maintenance, or considerations in the layout aiming at simplicity and low cost of operation, have not been sufficiently emphasized.

On p. 707 the efficiency of power transformers is given as from 96 to 99 per cent, which is considered too low as a minimum as well as a maximum value encountered in modern transformers. The reference to Transformer Losses on p. 78 (2 per cent for step-up and 2 per cent for step-down transformers) is also considered too high for average conditions. The statement on the same page that "transmission line efficiency changes only by reason of damage to the wire or insulators or by short-circuiting" will probably not be accepted by the operating engineer without challenge. The section on transmission lines gives the impression of incompleteness from the practical point of view. Nothing is said about the limitation of insulators, about various methods of grading them, and about the troubles to be guarded against, especially such things as porosity and electrical troubles caused by mechanical fatigue or deterioration. Something ought to be said about insulator specifications in paragraph 429, and about the various practices of testing and replacing insulators, work on live lines, etc. In paragraph 452 on Tower Foundations, only grillage foundations or dug concrete foundations are described, without mentioning the Malone anchors or other types of concrete anchors utilizing the method of springing holes by means of explosion. The lack of cost data, which is considered a general shortcoming of most sections, will be felt particularly in the section dealing with Transmission Lines, for which a great many typical examples could have been readily obtained.

The book should prove a valuable and in some respects an indispensable addition to the libraries of hydro-electric consulting engineers, of designers, construction organizations and operating companies. It will be an important reference book in the library of engineering schools. It is more suitable for the teacher or the post-graduate student than for undergraduates.

It is hoped that future editions will contain a more comprehensive digest of foreign material and present a critical analysis of available cost data and operating results. A compendium of this sort, if kept up to date by not too infrequent revisions, would become an every-day reference book or authoritative hydro-electric index, for which in this first edition a very promising start has been made.

Five Experts Collaborate

MUNICIPAL FINANCE—By A. E. Buck, in collaboration with other staff members of the National Institute of Public Administration and the New York Bureau of Municipal Research. New York: The Macmillan Co. Cloth; 6x9 in.; pp. 562. $4.

In writing this book Mr. Buck and his associates have rendered a distinct service. They have supplied a sufficiently comprehensive review of the fundamental principles of municipal finance to meet the needs of all but the specialist and they have put it all so plainly that any one can understand it and so attractively that reading the book is a pleasure. The preface states that the "book has been written mainly for city administrators, councilmen, financial officers, and those interested in the practical side of municipal finance," and expresses the hope that "it will be serviceable to teachers and students." This bespeaks a wide and varied class of readers—which the book deserves and the country needs. The greatness of the need is indicated by the billions of dollars being spent annually by our cities and towns and by the voices raised continually in protest over the amounts in question or as to the wisdom of the objects and methods of expenditure.

The book opens with a brief general review of the significance of municipal finance and a somewhat longer examination of financial administration and a still longer consideration of budgetary and auditing control. The first two of these chapters are by Mr. Buck, who is joined in the third by William Watson. The latter then goes on with general accounting and reporting and is rejoined by Mr. Buck in a chapter on cost accounting. Graphical methods are then taken up by Mr. Buck and

Edward M. Martin. After this Mr. Buck assumes the full burden for the two chapters on employment and pensions and on purchasing. A new author then appears—Philip H. Cornick—in collaboration with Mr. Watson on treasury management. Mr. Cornick then takes up, in succession, assessment of property for taxation and special assessments—sometimes known as assessments for benefits. Joint authorship again appears in a chapter on municipal revenues, in which Mr. Cornick is joined by Luther Gulick. The latter then handles debt administration. Mr. Buck then appears once more and, save for a selected bibliography and an index, both good, the curtain falls with a chapter on financing municipally owned utilities.

The chapters that come closest to the engineer are those on cost accounting, graphic statistics, purchasing, assessments, special assessments, and utilities. The longest is the one on assessments, a subject with which the engineer has more and more to do as time goes on, and next to it in length is the one on special assessments, which in many cities are in fact, if not in name, almost wholly administered by engineers, however much or little they may have to do with the policies followed.

The chapter on special assessments is one of the best in the book, and probably the most useful chapter for engineers. It brings out with notable clearness how much muddling and rule-of-thumb work there has been in this field, due to lack of discrimination between a mere pro rata distribution of cost and an assessment based on enhanced property values.

For the benefit of any who may not realize the fact from the mention of the names of Mr. Buck and his collaborators, it may be stated, as Mr. Buck says in his Preface, that the book has as its background twenty years of work by the New York Bureau of Municipal Research, during which more than a hundred surveys of city governments in the United States and Canada have been conducted. The more valuable testimony to the usefulness of the book, however, is its contents and the method of their presentation.

Fourth Issue of Municipal Index

THE MUNICIPAL INDEX, 1927: A Yearbook for City, Town and County Officials and for All Others Interested in Municipal Progress and Public Improvement Activities—Harold S. Buttenheim, Editor; Theodore R. Kimball, Engineering Editor. New York: American City Magazine Corporation. Cloth; 7x10 in.; pp. 711, including advertisement. $4.

The current issue of this annual, like the earlier ones, combines directory, tabular and text summaries with classified advertising, the latter distributed through the volume to accompany the 18 topical sections into which the other material is grouped. Both the advertising and the other material are indexed in detail. Among the new features are an atlas section, which includes state maps, with names and populations of the principal cities in the margins; a synopsis by states of the various classes of municipalities, with the title of the chief executive and election and budget dates for each state. Other sections, tables or text or both, deal with streets and roads, including snow removal, lighting and cleaning and traffic regulation; water and sewerage, including the treatment of both water and sewage; garbage and refuse collection and disposal; motor trucks; parks, playgrounds, etc.; police and fire departments. Among the directories are lists of chambers of commerce, civic organizations, city managers and mayors, the latter for places of 30,000 or more. Various bibliographies and summaries of current practice are included. Such statistics as those relating to water supply, street lighting, etc., do not make pretense of covering the whole country, but are useful as far as they go, and in some cases supplement figures for other cities in earlier issues of the Municipal Index.

Austria's Power Industry

REVIEWED BY EUGENE E. HALMOS
Hydraulic Engineer, Parsons, Klapp, Brinckerhoff & Douglas, Consulting Engineers, New York City

ÖSTERREICHS ENERGIEWIRTSCHAFT AUF VERANLASSUNG DES WASSERWIRTSCHAFTSVERBANDES DER ÖSTERREICHISCHEN INDUSTRIE—In verbindung mit Ing. P. Dittes; Ing. H. Grengg; Ing. L. Kallir, Ing. Dr. O. v. Keil-Eichenthum, Dr. G. Pokorny, Dr. E. Wiglitzky; Herausgegeben von Ing. Dr. J. Ornig. Wien: Julius Springer. Cloth; 7x11 in.; pp. 285. Mit 21 abbildungen im text sowie farbigen karten, 32 tabellen und 3 tafele. 36 reichsmarks in Germany.

Mr. Ornig's book gives a comprehensive survey of the present status of the power industry in Austria and a study of the means for developing the natural resources of the country for the supply of future needs. The book is published on the initiative of the Water Power Division of the Association of Austrian Industries, with the purpose of laying down a program of procedure for the unified development of power resources which should result in greatest benefit to the whole country with the least expenditure of capital.

The importance to the future of Austrian industry of a well-conceived, economical plan of developing hydro-electric power can be visualized when we consider the complete change in the economic situation that Austria underwent after the war. The area of the Austrian Empire was reduced from 120,000 to 33,000 sq.mi. and the population from 29,000,000 to 6,400,000, due to the secession of large provinces to the north, east and south. The total coal resources were reduced from an estimated total of 41,000,000,000 to 355,000,000 tons and the yearly production of coal from 45,000,000 to about 3,000,000 tons. The present yearly coal consumption being about 15,000,000 tons, Austria must import about 12,000,000 tons of coal every year against about 3,000,000 tons before the war.

At the present time, 832,000 hp. are installed in water wheels and 773,000 hp. in steam or internal combustion prime movers, a total of 1,605,000 hp. with a total yearly output of about 2,446,000,000 kw.-hr. The power plants in process of construction will increase the total installed capacity to about 1,790,000 hp. with a yearly output of 3,315,000,000 kw.-hr. Since 1920 about 226,000 hp. were installed in hydro-electric plants, the largest single installation being 45,000 hp. The projects described in this book call for supplying a deficiency of about 1,300,000,000 kw.-hr.

The body of the book consists of the statistical data of the present power plants, of their proposed enlargement and more efficient use and also of the present and future high-tension transmission lines. The statistics are discussed in a number of monographs. The first of these, written by Joseph Ornig, states the general problem of unified exploitation of the resources and the program of construction to supply future needs.

The second paper, by H. Grengg, is devoted to the description of water power resources, giving the data on the flow of the various rivers, on the problem of storage, and on the available heads. It is interesting to note in this connection that the development of power on the largest stream of the country, the Danube, is stated to be too expensive for present development.

The third paper, by L. Kallir, treats of electrical transmission, with due regard to present and future markets which must be reached. It is stated that there should be no difficulty in providing for a very complete long distance transmission system that would supply the power needs of the largest industrial center, Vienna, and the great industrial district of the province of Steiermark.

The next paper is devoted to the description of the industries using bulk power and especially to railroad electrification, to the steel industry, and to the use of electric energy in paper making.

On the whole, the book is extremely interesting inasmuch as it shows the tremendous struggle which a country deprived of coal must wage for existence. There is no doubt but that the future of Austria depends entirely on the development of its potential water powers. The work which has been recently done to this end and which will be done in the future should receive a great deal of attention among hydraulic and electrical engineers because of the necessity of economizing in every possible way, which will no doubt result in many ingenious designs.

British Water-Works Directory

BRITISH WATERWORKS YEAR BOOK AND DIRECTORY WITH STATISTICAL TABLES, 1926—London: British Waterworks Association, 173 Roseberry Ave., E.C.1. Cloth; 6x9 in. pp. 168. 21s. in England.

With the co-operation of the Institution of Water Engineers, the Water Companies Association and the Ministry of Health, the British Waterworks Association has started the annual named above. The first issue covers something over 200 water-works, mostly in England, Scotland and Wales, but with a few "overseas." So far as obtainable, the Directory portion of the volume gives the pertinent officials for each place, date the works were built, source made and character of supply, outside areas served, and water rates charged. Ten statistical tables give what is largely additional information for the various works. Among other data are extent of drainage area, storage reservoir capacities, aqueduct lengths, particulars of filters, service reservoirs, length of mains, numbers of meters, population and water consumption, financial operations, water charges—flat, meter, and to the municipalities—and "contributions in aid" from the municipal treasuries.

Although covering fewer works than the privately published annual, Water Works Directory and Statistics, discontinued during the Great War, the new enterprise will be heartily welcomed. Presumably it will include more water undertakings year by year until Great Britain, at least, is thoroughly covered.

Publications Received

THE MODEL BOND LAW drawn by the Municipal Borrowings Committee, has been reprinted from the February issue of the *National Municipal Review* (261 Broadway, New York City).

HOW TO APPLY FOR A POSITION by Letter and Interview is the subject of a well-written 72-p. pamphlet by Maurice H. Wessen, associate professor of Business English, University of Nebraska (50c. from College Book Store, Lincoln, Neb.).

YELLOW PINE SPECIFICATIONS for standard grades and sizes of lumber, flooring, material for structural framing and for painting and finishing, together with design information and data for the use of architects and engineers have been issued as Technical Bulletins 4 to 7 of the Southern Pine Association, New Orleans, La.

THE NOTABLE STUDIES of the Committee on Regional Plan of New York and Its Environs, in progress for several years, are admirably summarized by Thomas Adams, general director, in a pamphlet which includes a detailed report of regional meetings. (Planning the New York Region; paper; pp. 129; illustrated. 75c. from committee named above, 130 E. 22nd St., New York City.)

IN A STUDY by Prof. Rodolfo E. Ballester, director of irrigation works on the upper Négro River (Buenos Aires, Argentina, S. A.) it was found that the canals whose velocity is determined by the formula $V_o = .52d^{.11}$ can be easily maintained and that the formula of Ganguillet and Kutter can be used with most precision on the several types of canals studied using a value of $n = 0.020$. The pamphlet is printed in Spanish.

DESCRIPTIONS of the sewerage system of Bridgeport, Conn., which includes Reinsch-Wurl screens, and of screens of the same type, but of 70-m.g.d. capacity, and the Jamaica sewage-works, Borough of Queens, New York City, make up a pamphlet being distributed by the Sanitation Corporation, New York City. The Bridgeport description was written by James A. McElroy, city engineer, Bridgeport, and is reprinted from the 1920 *Proceedings* of the Connecticut Society of Civil Engineers.

CONCRETE DRAIN TILE in alkali soils is the subject of the larger part of the Review of Work of Co-Operative Tile Drain Laboratory, with Recommendations, published by the Minnesota Department of Drainage and Waters (St. Paul) and written by D. G. Miller, drainage engineer, U. S. Department of Agriculture. Besides the two governmental agencies named, the University of Minnesota, through its Department of Agriculture, is co-operating in the investigations, which have been conducted for some six years.

BITUMINOUS COAL was the subject of an international conference conducted by the Carnegie Institute of Technology, Pittsburgh, Pa., last November. The papers and discussions contributed by delegates from 13 countries are now available in a bound volume of 830 pages, published by the Institute. Many noted speakers dealt with the available supply, new developments and utilization. There were sectional meetings on power, high temperature distillation, gasification, fertilizer production, smokeless fuel and other topics.

EXPERIMENTAL studies of water purification conducted at Cincinnati, Ohio, by the U. S. Public Health Service are reviewed by F. J. Moss, assistant sanitary engineer, and H. W. Streeter, sanitary engineer, in a reprint from Public Health Reports, Oct. 1, 1926. Mr. Moss describes the plant and Mr. Streeter reviews the results. The installation studied, Mr. Moss states, "may serve as an example of the possibilities which exist for constructing highly efficient water-purification plants for small communities of less than 2,000 inhabitants."

A PRACTICAL PAPER, entitled "Estimating Quantities of Materials for Concrete," by Stanton Walker, director, Engineering and Research Division of the National Sand and Gravel Association (Munsey Building, Washington, D. C.) has been issued as Bulletin 1 of that organization. The paper gives formulas and tables for proportioning concrete, based on the fact that the volume of concrete is equal to the volume of solids in the aggregate plus the volume of cement so long as there is a negligible quantity of unfilled voids or entrained air.

THE VENTILATION OF VEHICULAR TUNNELS is the subject of a pamphlet published by the American Society of Heating & Ventilating Engineers, 33 W. 39th St., New York City. ($0.50 to members, $1.00 to others.) It is a reprint from the *Journal* of the society, 1926, and contains a report of the U. S. Bureau of Mines to the New York and New Jersey Bridge & Tunnel Commissions on the ventilation of the Holland Tunnel at New York, by A. C. Fieldner, Yandell Henderson, J. W. Paul, R. R. Sayers and others.

ANOTHER VOLUME OF THE PORT SERIES has been published by the Board of Engineers for Rivers and Harbors, War Department, in co-operation with the U. S. Shipping Board. It is No. 16 of the series and concerns the ports of Baltimore, Md., Washington, D. C., and Alexandria, Va. Like its predecessors, this report gives full information as to

port facilities and harbor conditions and the amount of foreign and domestic commerce handled through each port. It is illustrated with large folding maps and airplane views. ($1.10 from Superintendent of Documents, Washing-ton, D.C.)

SIMULTANEOUS with the initial production of the new beam sections of the Carnegie Steel Co. (Pittsburgh, Pa.) a pamphlet giving dimensions and properties of the sections was issued. Now a fuller handbook appears, giving in addition a collection of tables of safe loads for these sections used as beams and columns. Various current specification requirements are separately covered by groups of tables. Special typography has been used in these tables to bring out significant features prominently, in order that errors in taking out quantities may be minimized. A flexible leather binding adds to the utility of the book.

NEVER BEFORE have there been brought together in compact and handy quick reference form so many engineering and building construction cost figures as are presented in a pamphlet entitled *Engineering News-Record* Construction Costs, 1910-1926. Of the many useful tables in the pamphlet the first gives the *Engineering News-Record* Construction Cost Index by years from 1903 to the base year 1913, and by months from 1914 to 1926. This is supplemented by curves showing the yearly and monthly cost index number from 1914 to 1926. Of particular value is a table giving high, low and average prices from 1910 to 1926 of bars, brick, cast-iron pipe, cement, crushed stone, gravel, lead, linseed oil, lumber, sand, steel shapes and hollow tile; some of the quotations cover many cities, the highest being cement, with 30. Hourly labor rates for bricklayers, hod carriers, carpenters, structural iron workers and common laborers are given for seven cities distributed from the Atlantic to the Pacific. There is then a cost analysis, under 43 heads, for five large buildings. The pamphlet closes with unit bids on 50 typical jobs of 1926. (Paper; 9x12 in.; pp. 48; tables and diagrams. $1 from Business News Department, McGraw-Hill Publishing Co., 10th Ave. at 36th St., New York City.)

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

ALPHABETICAL INDEX U. S. Government Master Specifications, Promulgated by the Federal Specifications Board—Circular 319, Bureau of Standards. Paper; 6x9 in.; pp. 18. 10c. from Superintendent of Documents, Washington, D. C.

THE BACTERIOLYTIC TANK SYSTEM IN SOUTH AUSTRALIA—By W. Ramsay Smith, D.Sc., Permanent Head, Department of Public Health of South Australia. 7th edition. Adelaide, S. A.: State Department of Public Health. Paper; 5x8 in.; pp. 48 and appendix of line cuts and halftones.

The present edition reviews a quarter century of experience with sewage tanks, chiefly for houses and other single buildings, of which it appears that thousands have been constructed with the approval of the department named.

DESCRIPTIVE BIBLIOGRAPHY ON OIL AND FLUID FLOW AND HEAT TRANSFER IN PIPES—By Joe B. Butler. Rolla, Mo.: School of Mines and Metallurgy, University of Missouri. Paper; 6x9 in.; pp. 62.

THE DISTRIBUTION AGE: A Study of the Economy of Modern Distribution—By Ralph Borsodi, Author of "National Advertising," "The New Accounting," etc.; With an Introduction by Lew Hahn, Managing Director of the National Retail Dry Goods Association. New York and London: D. Appleton & Co. Cloth; 6x8 in.; pp. 321; 11 plates (or charts). $3.

DER EISENBAU: EIN HANDBUCH FÜR DEN BRUCKENBAUER UND EISENKONSTRUKTEUR—By Luigi Vianello, in dritter auflage umgearbeitet und erweitert von Dr.-Ing. Luz David, Magistratsbaurat bei der baupolizei Berlin. Berlin and Munich: R. Oldenbourg. Paper; 6x9 in.; pp. 617; 640 line cuts. Paper, 30, bound, 31.5 reichsmarks in Germany.

Third edition, increased about a third in size. New material on mathematics and mechanics, bridge cranes, arched roofs and framing. Foreword states that old portions have been revised to date; earlier editions reviewed in *Engineering News*, Aug. 17, 1905, and March 13, 1913.

FIELD ASTRONOMY FOR ENGINEERS AND SURVEYORS—By David Clark, M.A., B.Sc., M.Inst.C.E., M.Inst.C.E.I., Assoc-M.Am.Soc.C.E., Professor of Civil Engineering, University of Dublin. London: Constable & Co., Ltd. Cloth; 5x8 in.; pp. 164; 50 halftones and line cuts. $3.50 from D. Van Nostrand Co., New York.

FINANCIAL STATISTICS OF STATES (1925)—Bureau of the Census. Paper; 6x9 in.; pp. 131; 21 tables. (20c. from Superintendent of Documents, Washington, D. C.)

FOURTEENTH INTERNATIONAL NAVIGATION CONGRESS, CAIRO, 1926. Two thick portfolios containing scores of 6x10-in. pamphlets, some illustrated, on (1) Inland Navigation and (2) Ocean Navigation. Published by Executive Committee, Permanent International Association of Navigation Congresses, 38 Rue de Louvain, Paris; American Headquarters, 2713 Munitions Building, Washington, D. C. $10, which includes membership in the Association.

Under Inland Navigation, the first subject considered is dams and intakes and the adjoining navigation work. Next, the technical and the commercial working of waterways—organization, rates, etc., including electric power and irrigation, is taken up. The arrangement and equipment of river ports for main navigation and their connection with the railway net, and recent steps to reduce the period of closure of canals and canalized rivers, conclude the first portfolio. Under Ocean Navigation, the subjects treated are quays of great depth and breakwaters or jetties, both in tideless seas; general design of fishing harbors; large maritime canals; reception and storage of liquid fuels (metallic and reinforced-concrete reservoirs), including fire protection and the distribution of the liquid fuel in the ports; intensive suction dredging, mainly in swelling seas.

GROUND WATER RESOURCES OF THE SOUTHERN SAN JOAQUIN VALLEY—By S. T. Harding, Consulting Irrigation Engineer. Sacramento, Calif.: State Department of Public Works. Paper; 6x9 in.; pp. 146; illustrated.

THE LA FOLLETTE SYSTEM for the Complete Solution of the Right Triangle. Kaycee, Wyo.: William La Follette. Paper; 6x9 in.; pp. 11. $1.
Seven pages of description and 4 pp. of tables, the latter giving Alpha, Beta, Hypothenuse, altitude angle and base angle.

METHODS OF COAL ANALYSES: Fuel Research, Physical and Chemical Survey of the National Coal Resources, No. 7. London: H. M. Stationery Office. Paper; 6x9 in.; pp. 35. 9d.

A NATIONAL PROGRAM OF FOREST RESEARCH—Prepared by Earle H. Clapp, as the report of a special committee of Forest Research of the Washington Section of the Society of American Foresters, consisting of R. C. Hall, Valuation Engineer, Timber Section, Bureau of Internal Revenue; A. B. Hastings, Assistant State Forester of Virginia. Earle H. Clapp, Chairman, In charge of the Branch of Research, U. S. Forest Service. Washington, D. C.: The American Tree Association. Paper; 7x10 in.; pp. 232.

PIT AND QUARRY HAND BOOK, 1927 Edition: Cement, Lime, Gypsum, Sand and Gravel, Crushed Stone Industries [H. W. Munday, Editor; 11 Special Contributors]. Chicago: Complete Service Publishing Co., 538 S. Clark St. Flexible; 6x9 in.; pp. 608. $5.

Besides special articles on plant design, drilling and blasting and many other subjects, there is a section on shipping and an Equipment Catalog Index and Directory of Trade Names.

REINFORCED CONCRETE CONSTRUCTION, VOLUME I: FUNDAMENTAL PRINCIPLES, Including Numerous Tables and Diagrams to Facilitate the Calculation and Design of Reinforced Concrete Structures—Prepared in the Extension Division of the University of Wisconsin by George A. Hool, S.B., Consulting Engineer, Professor of Structural Engineering, University of Wisconsin. Third Edition. [Engineering Education Series.] New York and London; McGraw-Hill Book Co., Inc. Cloth; 6x10 in.; pp. 380; many line cuts, halftones, charts and tables. $3.50.

In the third edition of this University Extension textbook "most of the material," the Preface states, "has been completely rewritten," and "chapters have been added on shear and moment considerations in continuous beams," etc. Credit for assistance is given to Prof. Harry E. Pulver.

THE RELATIONS BETWEEN CROP YIELDS AND PRECIPITATION IN THE GREAT PLAINS AREA—By E. C. Chilcott, Senior Agriculturist, in Charge of Dry-Land Agriculture, Bureau of Plant Industry. Paper; 9x11 in.; pp. 94; many tables and diagrams. 30c. from Superintendent of Documents, Washington, D. C.

THE SCIENCE AND PRACTICE OF URBAN LAND VALUATION: An Exposition of the Somers Unit System—By Walter William Pollock, President, The Manufacturers' Appraisal Co., and Karl W. Scholz, Ph.D., Assistant Professor of Economics, University of Pennsylvania. Philadelphia: The Manufacturers' Appraisal Co. Cloth; 6x9 in.; pp. 315; numerous line cuts. $5 net; 21s. in England.

SIMPLIFIED ROOF FRAMING—By J. Douglas Wilson, Head of Building Trades Department, Frank Wiggins Trade School, Los Angeles, Calif., and S. O. Werner, Formerly Head of Building Construction Department, High School, South St. Paul, Minn. [McGraw-Hill Vocational Texts.] New York and London: McGraw-Hill Book Co. Cloth; 6x8 in.; pp. 122; many line drawings. $1.40.

For persons without training in mechanical drawing, geometry or trigonometry. Each chapter devoted to a typical roof and each section to a rafter.

DIE STÄDTEHEIZUNG: Bericht über die vom Verein Deutches Heizungs-Ingenieure E. V. einberufene Tagung vom 23. und 24. Oktober 1925 in Berlin—Im Auftrage des Arbeitsausschusses Verfasst von J. Fichtl, Mag. Baurat, Dipl.-Ing.; Dr. A. Marx, Ingenieur und Privatdozent; und O. Frohlich, Ingenieur. München und Berlin: R. Oldenbourg. Paper; 6x9 in.; pp. 209. 8 reichsmarks, in Germany.

TABLES FOR ALBERS PROJECTION—By Oscar C. Adams, Geodetic Mathematician. Special Publication 130, U. S. Coast and Geodetic Survey. Paper; 6x9 in.; pp. 18, including 11 pp. of explanatory text. 5c. from Superintendent of Documents, Washington, D. C.

TIDAL BENCH MARKS, STATE OF RHODE ISLAND—By L. A. Cole, Associate Mathematician, U. S. Coast and Geodetic Survey. [Publication No. 128.] Paper; 6x9 in.; pp. 16; halftones and tables. 10c. from Superintendent of Documents, Washington, D. C.

TYPICAL METHODS AND DEVICES for Handling Oil-Contaminated Water from Ships and Industrial Plants—By F. W. Lane, A. D. Bauer, H. F. Fisher, and P. N. Harding. Paper; 6x9 in.; pp. 66; illustrated. Technical Paper 385, U. S. Bureau of Mines. 15c. from Superintendent of Documents, Washington, D. C.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

In Defense of High Tensile Strength Reinforcing Steel

Sir—Action that has precipitated interesting discussion among engineers during the past few weeks occurred at the recent meeting of the American Concrete Institute in Chicago when the preliminary report of Committee E-1 on recommended concrete building regulations was passed by contested vote to the status of tentative standard.

Section C-7 of these regulations entitled "Metal Reinforcement" is unique in providing that in the case of bars on which bending is required, high tensile strength reinforcing steel be eliminated in sizes over ⅜-in. diameter. If accepted for future use as a standard, this provision, for obvious reasons, would automatically place a definite restriction on the use of both hard grade billet steel and rail steel bars in many classes of work and on all projects requiring reinforcement in sizes over that given as a limit.

Regardless of opinion underlying the report of the committee it is difficult to find in this any other than the case of a recommended building regulation assuming power not ordinarily conceded to such instruments.

The remarkable success of both grades of material, under indictment by this recent action, is well known to all engineers, architects and contractors. Economy and increased safety in design have been two of the advantages especially ascribed to their use. Furthermore, there have been in existence for years standards for both materials adopted by the American Society for Testing Materials, the standard for rail steel reinforcing bars being established at the same time as that covering billet steel reinforcing bars. For all these reasons there is noticeable evidence of the surprise of numerous engineers at this new provision in the recommendation of the American Concrete Institute.

It is not necessary to relate the various tests and the experience that underly the present general acceptance of rail steel reinforcing bars. It is significant, however, that almost simultaneously with the action taken by the American Concrete Institute there became available the report of the U. S. Department of Commerce Building Code Committee, Bulletin BH-9, with its recommended building code requirements for working stresses in building materials. The latter report, emanating from a committee of recognized high authority in matters of building regulation and promulgated only after a thorough study, makes a very definite statement endorsing hard grade reinforcing materials and reads in Section 8, p. 22 as follows:

> A favorable consideration is the fact that overloads which would produce a permanent open crack in structures reinforced with mild steel will not do so when reinforced with high carbon steel, because the steel, still elastic, draws the crack together. Reinforcing bars rolled from either billet steel or steel rails are suitable reinforcement. Some question has been raised in past years as to the dependability of bars from the latter source and in 1922 extensive tests were made at the Bureau of Standards to determine the suitability of this material for general reinforcement purposes. The committee, after careful consideration of these and other recent tests and of experience with their use, is convinced that if such material meets the American Society for Testing Materials Standard Specifications for Rail Steel Concrete Reinforcement Bars, serial designation: A16-14, it is suitable for concrete reinforcement. The joint committee report also supports this conclusion. No question of public safety is involved.

Building codes are written with the view of protecting life and property and toward that end are entitled to authority of requiring standard materials. It is, however, entirely out of harmony with the economic scheme to permit a debatable difference of opinion to discriminate between standard materials so widely accepted for years.

It has been repeatedly proved and stated by authority that no question of public safety is involved in the use of rail steel reinforcing bars. In view of this opinion it is immediately seen that any code presuming to regulate the selection of material on the basis of any physical property, not affecting safety, is subject to criticism.

Through a process of repetition or copying, a few building codes have carried down to recent years clauses providing for the use of only mild steel reinforcement. It is significant, however, that in the process of general revision of all these codes, at best a cumbersome and slow procedure, those from cities containing the bulk of our country's population have eliminated the clauses that have discriminated between the various grades of reinforcement covered by A. S. T. M. Standards and approve use of rail steel bars.

Adequate safeguard against the use of unsatisfactory material is provided by A. S. T. M. specifications covering reinforcement. These standards have been used for many years, not only in this country but in others, have formed the basis for all important building regulation and have governed the quality of material used in a large share of the finest reinforced-concrete structures now in existence.

Reinforced concrete, as a material for construction is now under indictment as a result of recently published opinion that includes the statements of a well-known educator all of which has been the subject of considerable discussion during the past several weeks. Without considering the merit of argument advanced either for or against the use of reinforced concrete it would seem that our societies and association concerned with its advancement should direct their efforts toward the refutation of criticism rather than toward the denial of a standard practice used in the art for years past. The bewilderment that is certain to result among engineers and those of the building profession who have been advocates of reinforced concrete would be a heavy blow to the industries of many descriptions that have developed around the popular and increasing use of concrete.

Should the report under discussion ever assume the proportion of a standard of the American Concrete Institute and, as such, enjoy the prestige endowed by its source, we anticipate among those of the building profession in general, a widespread reaction amounting to confusion; and as recommendations for building regulations and codes are concerned with measures for the protection of public safety, this new recommendation of the American Concrete Institute will indicate the surprising fact that a standard material already used for the past twenty or more years is endangering daily the safety of millions that now occupy or use offices, hotels, apartments, hospitals and other public buildings, drive or walk on roads and bridges and in many other ways trust to the safety of structures reinforced with rail steel bars.

If we must differentiate between limits of a few thousand pounds in tensile strength as our margin of surety, satisfaction or safety and if we are now told that those standards we recognized as the highest authority on building materials and construction for the past quarter century are wrong, what is to assure us that those who tell us this now are right?

Since the American Concrete Institute report by its Section C-7 on metal reinforcement would in effect eliminate the use of all high strength reinforcement, it assumes a stand on this question in opposition to the opinions of such bodies as the Department of Commerce Building Code Committee, the Joint Committee on Concrete and Reinforced Concrete and the American Society for Testing Materials.

As has already been mentioned it is significant that the U. S. Department of Commerce Building Code Committee report, endorsing the use of high strength reinforcing bars, both rail steel and hard grade billet, and the American Concrete Institute Committee E-1 report with its provision for elimination of larger sizes of these grades were promulgated at almost the same time. This difference of engineering thought is confusing in a large degree to the profession in general and opens to any opponent of reinforced concrete an avenue for attack on that type of construction.

Clearly, rail steel and hard grade billet steel reinforcing bars have earned too long a record of satisfactory performance in construction to admit the possibility of any recommendation, in which they are denied recognition, becoming a standard for the control of our future building regulations.

Chicago, Ill., April 9, 1927.

H. P. Bigler,
Engineering Secretary, Rail Steel Bar Association.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Am. Soc. C. E. Board Meets in Asheville

Much Business Transacted at Sessions Preceding Spring Meeting of the Society

Engineering News-Record Staff Report

The Board of Direction of the American Society of Civil Engineers met in Asheville, N. C., on April 18 and 19 preceding the spring meeting of the society. The resignation of Con M. Buck as director from District 14 on the grounds of ill health was accepted and in his place the board elected Gilbert J. Bell of Topeka, Kan. George T. Seabury, Otis E. Hovey and William J. Boucher were re-elected secretary, treasurer and assistant treasurer, respectively. The board authorized the appointment of a new assistant technical editor and a new assistant to the secretary to head up the technical activities of the society. A new student chapter was authorized at Manhattan College, New York City. Places were fixed for future meetings of the society as follows: spring of 1928, Washington, D. C.; convention 1928, Buffalo, N. Y.; fall 1928, San Diego, Calif.; spring 1929, somewhere in Texas; convention 1929, Milwaukee, Wis.; fall 1929, Boston, Mass.

Additional appropriations of funds were made for the earthquake committee and to cover the society's participation in the test of the Swift Island Bridge, a reinforced-concrete structure which is to be tested to destruction. The board approved the limitation of "Transactions" to one volume each year to contain such papers only as shall be adjudged to show exceptional or permanent value. The secretary was authorized to prepare a circulating library of motion picture films dealing with engineering subjects for the use of local sections or student chapters.

With a view to the development of more effective co-operation between the four founder societies in matters of common interest both with respect to technical and professional activities, a committee of three members of the board was authorized to study the organization, objectives, resources and general operation of American Engineering Council, United Engineering Society, Engineering Foundation, American Engineering Standards Committee and other similar bodies engaged in joint engineering activities. This committee is to report to the Board of Direction at its next meeting, which is in July.

The Board approved a report of the committee on professional conduct dealing with a specific case in which an engineering firm offered its services for preliminary study and design, payment for which was to be contingent upon the actual award of a contract for the proposed work. The committee found that such practice is not in conformity with the provisions of the code of professional practice adopted by the society to the effect that it is improper for engineers "to engage in the practice of making preliminary studies and estimates of costs for specific projects or to render other professional service or advice without adequate compensation."

New Orleans Drainage Services Damaged by Storm

Fourteen inches of rain falling in less than 18 hr. most of it in 10 hr. on April 15 and 16 was theoretically equivalent to two whole days of full capacity of the New Orleans drainage system, according to a telegram to this journal from George G. Earl, general superintendent of the New Orleans Sewerage and Water Board.

Mr. Earl continues: "Intense lightining about midnight at the peak of the storm caused a break in the New Orleans public service 15,000-volt power line which fell on and short circuited the main transmission lines burning out the sewerage and water board powerhouse, one of the two 6,000-kw. generators and damaging many portions of the city transmission system. This reduced the discharging capacity from 8,000 sec.-ft. to 1,600 sec.-ft. from midnight to about 7 a.m., when repairs enabled the output to go to 35 per cent from 7 a.m. to 2 p.m. After 2 p.m. further repairs permitted output to about 81 per cent of capacity. The main portion of the city was relieved from water within an hour or so after the cessation of the rain. Accumulated water in the newer lower areas reached a maximum depth of about 3½ ft. above curb levels.

"Rain started 10 a.m. Friday but by 10 p.m. Sunday night or in a period of 2½ days all the flooding in the well-populated areas was removed."

Engineering Fifty Years Ago

From *Engineering News*, April 21, 1877

THE number for March, 1877, of the "Transactions" of the American Society of Civil Engineers contains three papers of interest; a short one on "A Water Conduit Under Pressure," by John F. Fanning; a report by Charles Macdonald on the "Failure of the Ashtabula Bridge," which is in harmony with the views already expressed in our pages; and a paper on "Co-ordinate Surveying" by Henry F. Walding.

Record Flood Predicted in Mississippi Valley

High Stages in Tributaries Increase Danger — Rainfall at New Orleans Excessive

Heavy rains in southern Missouri and northern Arkansas, continuing for ten days when flood stages had theretofore been reached in the upper Mississippi, combined with rains of a cloudburst intensity around New Orleans, have combined to raise the Mississippi River to general flood heights yet unrecorded. The gist of the condition along the river is contained in three despatches to *Engineering News-Record* from Col. Charles L. Potter, chairman of the Mississippi River Commission; Dr. Isaac M. Cline, senior meteorologist of the U. S. Weather Bureau at New Orleans, and John Klorer, commissioner of public works in that city. Col. Potter wires the following:

"On April 5 rain began again and continued daily for ten days, being very heavy in southern Missouri and northern Arkansas. At Cairo, Ill., the gage showed a higher stage on April 15 than any previous record, with a foot more of water in sight when the levee broke on the west bank of the river about 40 miles below Cairo, slowing down the expected rise at Cairo. Cairo reached 56.3 the morning of April 18 and had risen 0.3 ft. during the previous 24 hr. The previous high at Cairo was reached in 1913 when the gage reading was 54.7 ft. The estimated height of the greatest previous confined flood is 55, so all records are exceeded. The St. Louis River is still rising slowly but the Ohio is falling and we hope that the Cairo stage will not materially increase. Another break in the levee occurred the night of April 15 on the right bank at Walnut Bend, 25 miles above Helena. Both of these breaks are near the lower end of basins where the country is already flooded by back water entering mouths of tributaries, so their effect is to add somewhat more to the area already flooded. Otherwise we are holding out, but the most disturbing feature is that both the Arkansas and White Rivers are coming in with practically record gages, a thing that seldom synchronizes with the Mississippi River crest. It is impossible yet to predict their effect but it looks serious all along the line, and very serious below the Arkansas River." Col. Potter adds that the Mississippi River Commission started on April 19 on the semi-annual inspection of the river to New Orleans.

In New Orleans rain of a cloudburst intensity fell April 15 and 16. Dr. Cline reports as follows on this:

"The rainfall at New Orleans was 14 in. within 19 hr. from 9 a.m. on April 15 to 4 a. m. April 16. The fall was 7.34 in. within four hours from 10 p.m. to 2 a.m., including two 30-min. periods when rain fell at a rate of about 4 in.

per hour. The greater part of the city was flooded immediately following the maximum fall, but the area within ten to twenty blocks of the river was drained quickly and no surface water remained there the morning of April 16. The lowest portions of the city were not completely drained up to April 18.

"Morgan City, La., 90 miles west of New Orleans, reported 15.55 in. of rain for 24 hr. ending 7 a.m., April 16. Heavy rains occurred during the week ending April 16 in the middle and lower Mississippi valleys, mostly on the west side of the river, causing very high water in all tributaries on that side. The highest flood stages of record already have been reached at Cairo and Arkansas City. Warnings have been issued to the effect that unprecedented stages in New Orleans River district within the next three to four weeks will prevail if the levees hold. Stages forecast are as follows: Natchez, 57.3, previous highest, 55.2; Baton Rouge, 47.3, previous highest, 45.7; Donaldsonville, 37.5, previous highest 35.0; New Orleans 23.2, previous highest 21.3."

Mr. Klorer, commissioner of public works at New Orleans, reported that no "great difficulty is expected in meeting these river flood conditions insofar as the levees are concerned that are situated in front of the city of New Orleans. They have ample cross-section and the deficiency of a few feet in height can be successfully supplied by the previously tried methods of using sand bags. The entire length to be raised between now and May 1 will not exceed 15,000 lin.ft. and the height of this topping will vary from 2 ft. to 4 ft."

John E. Ericson, Chicago City Engineer, Dies

John E. Ericson, city engineer of Chicago, Ill., for many years, died April 16 at a hospital in Chicago after a short illness, aged 69 years. He was born in Sweden in 1858, graduated in 1880 from the Royal Polytechnic Institute in Stockholm, and soon thereafter came to the United States. His connection with municipal engineering in Chicago dates from 1884 when he became draftsman in the water department, and he became assistant in the bureau of engineering in 1885. With the exception of short periods at other work he served the city until the time of his death, becoming assistant city engineer in 1893 and city engineer in 1897. One of his chief services was the development of the city's water supply system. A more extended obituary will be given in these columns April 28.

Mount Hope Toll Bridge Bill Passed

On April 14 the Rhode Island legislature passed the Mount Hope bridge bill, and Gov. Pothier approved it. The bill authorizes a private corporation to build a toll bridge from the island of Rhode Island to the mainland near Bristol. A span of about 1,200 ft. is involved. The bill requires the bridge to be completed by 1931.

Scaffolding Around Tower of N. Y. Hotel Burns

Working Platform at 38th Story of Netherland Not Reached by Fire-Fighting Equipment

Fire, starting from an undetermined cause, burned the construction scaffolding on the tower of the Netherland Hotel, New York City, April 12, causing damage estimated at only $25,000. The principal loss was in the scaffolding and three elevator motors, though burning brands falling into the streets and on nearby buildings endangered other property. There was little or no wind, and this danger was easily controlled by the firemen. The fire was first noticed about 8 o'clock in the evening and is presumed to have been caused by a cigarette falling into the waste on the scaffold. It burned for more than four hours. The building is of 38 stories with a tower. The scaffolding extended from the 38th story to the top of the tower, a vertical distance of about 70 ft., and completely surrounded the tower.

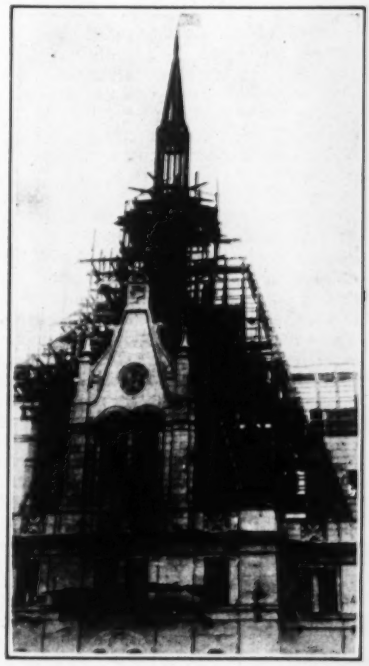
Efforts of the Fire Department to reach the burning tower scaffolding were unavailing. One theory for this failure is the inadequacy of fire equipment, though the Fire Department contends that had the standpipe been in proper condition, water would have been carried to the tower. The attempt was made to reach the burning scaffolding from across the street through a standpipe running to the top of the Savoy Hotel, but that attempt was ineffectual the water not even reaching across the street. Fire pumpers have a capacity of 700 g.p.m. and the strength of the hose is rated to withstand a pressure of 250 lb. per sq.in. Inasmuch as no water was available to fight the fire, most of the scaffolding burned together with a construction hoist tower, the latter being consumed down to the twentieth floor or to that point where water could reach it.

The scaffolding was supported mainly by I-beam outriggers just below the 38th floor. It was built up principally of 4x4-in. posts, 1½x9-in. diagonal bracing and 2x9-in. struts. It is estimated that 200,000 ft. b.m. including both scaffolding and hoist tower were consumed by the fire.

Only minor structural damage to the permanent work of the building resulted. Some of the exposed steel members of the tower framing, chiefly purlins, were distorted. Formwork still in place under the tower girders were burned, spalling the encasing concrete somewhat. Brickwork contiguous to the burned hoist tower will be replaced due to defacement.

There was a standpipe in place on the new building with an outside siamese connection. This, firemen attempted to use, but to no avail. The fire department contended that the standpipe was uncapped but this bad condition has not been verified. The fire department has no jurisdiction over the installation of first-aid fire equipment until the structure becomes habitable.

(*Continued on p. 667*)



HOTEL NETHERLAND AND TOWER
View above shows tower after fire. Favorable wind saved scaffold at right. At right above may barely be seen stream of water from standpipe of new Savoy Hotel across street from Netherland.

Ocean Outfall Permit Granted Los Angeles Project

The California State Board of Health on April 4 granted a permit to Los Angeles County Sanitation District No. 2 to build an outfall sewer extending 5,000 ft. into the ocean at White's Point, the location that the district has desired from the start but which has been strenuously opposed on the ground that beach pollution would result. A brief review of the case was published in *Engineering News-Record*, Dec. 30, 1926, p. 1094, and the project as a whole was described June 18, 1925, p. 1026.

The permit is for the discharge of 200 sec.-ft. of "settled sewage" from a sewage settling work on shore which is to be operated without nuisance or menace to health. The permit specifies that "garbage, fecal matter, solid matter or oily sleek recognizable as of sewage origin from said district shall not be visible at any beaches, shores, fishing or pleasure piers or breakwaters" and reserves the right to require changes and additions to the plant and outfall when the board considers them necessary.

Permit for the White's Point location comes after two years of controversy during which various alternative locations have been opposed on the ground of beach pollution. The board of health last year indicated that approval could be secured for a location along the San Pedro breakwater and extending thence out into the ocean but Los Angeles refused the rights-of-way that would have been necessary.

N. Y. Subway Fire Damages City Service Cables

Two fires between the wooden street deck covering the construction operations on New York's new Eighth Avenue subway, one on the evening of April 17, the other on the following morning caused severe damage to underground cables of the police and fire departments, of the N. Y. Telephone Co., and of the N. Y. Edison Co. Damage to the street decking and the contractors plant was slight and covered by insurance. Between three and four days were required to restore all the cables. It is claimed that more cables are concentrated at 36th St. and 8th Ave. than at any other point in the world. The burning of cable insulation caused huge billows of black smoke but the fires were under control before any serious flames could break out. The burning area, in which a number of separate fires broke out, extended from 34th to 38th Sts.

The cables ordinarily are protected by brick or concrete conduits but during construction must necessarily be exposed, they are hung from the deck framing. It is thought the fires were started from short circuits.

Would Build 95-Mile Railroad

The Clinton & Oklahoma Western R.R. has applied to the Interstate Commerce Commission for authority to construct an extension of its main line from Cheyenne, Okla., to a point near Pampa, Tex., approximately 95 miles.

Sessions on Traffic Held in New York and Chicago

National Highway Traffic Association and Auto Commerce Chamber Sponsor Two Meetings

Two traffic conferences of more than local importance were held last week: one, the annual meeting of the National Highway Traffic Association and the other sponsored by the National Automobile Chamber of Commerce in Chicago.

The presentation and consideration of nineteen national committee progress reports filled an afternoon and an evening session of the annual meeting of the National Highway Traffic Association held at the Automobile Club of America, New York, on April 15. The attendance varied from 50 down to about 25 and included engineers, professors and others interested in traffic and its progress. Arthur H. Blanchard, president, presided at the afternoon session, while David Beecroft, vice-president, was chairman of the evening session. Terminology of traffic control, traffic signals, brake and brake testing, loading of trucks, roadways, compulsory motor vehicle insurance, pedestrian traffic and use of automobiles by university students were among the numerous subjects discussed. A wide divergence of opinion was shown to exist as to the causes of traffic ills as well as to their proper treatment, but the feeling was expressed that traffic is primarily an engineering problem and should be handled as such.

With an attendance of about 75, including engineers and city officials, an informal city-traffic conference arranged by the National Automobile Chamber of Commerce, and held at Chicago on April 13-14, discussed at three sessions a wide variety of subjects covering traffic surveys, city planning, the parking problem, traffic signals and traffic control in general.

That a traffic survey is an engineering problem was emphasized by Miller McClintock, who was in charge of the recent extensive survey at Chicago. But as a rule it is not given expert study as in the case of problems of improved water supply or sewerage. Instead, it is attacked in a haphazard way and as affecting limited districts, rather than as a city-wide problem. No recommendations for general application can be made, since local conditions of topography, streets and traffic vary so widely, so that methods desirable and effective in one city might be undesirable and quite unsuccessful in another Mr. McClintock pointed out. After a traffic code had been adopted there should be a permanent engineer in charge of putting the system into effect and to study local traffic problems.

As to parking and garages, Mr. McClintock considered that even high-priced downtown property could be developed successfully for garages. This opinion was presented also by H. B. Peabody, of the Detroit Garage Co., who referred to investigations and experiments as to the prospective success of large multi-story garages in that city.

That automatic traffic-control signals are in many cases ineffective and may actually hamper traffic movements was a point made in a long address by E. J. McIlraith, assistant engineer of the Chicago street railways. With the system now in use in Chicago, the average speed in busy streets is less than 9 m.p.h., while with a progressive system allowing movements for more than one block, this might be nearly doubled. The difficulties and dangers of diagonal intersections were noted by Col. A. B. Barber, Washington, D. C. Uniformity in signs on outlying highways was urged by Robert Kingery, secretary of the Chicago Regional Planning Association. Mr. Kingery also outlined the work of the association in co-ordinating highways to form desirable through routes.

Transportation features that need to be considered in city planning were discussed by J. R. Bibbins, consulting engineer, Washington, D. C., who recommended that developments should be based on twice the present volume of traffic. To facilitate rush-hour traffic, he suggested that three-fourths of the width of main streets be assigned to inbound traffic in the morning and to outbound traffic in the evening. An address by E. S. Taylor, manager of the Chicago Plan Commission, showed the peculiar local situation of traffic equivalent to one-third of the population of Chicago entering and leaving the congested business district daily. This is due to the centralization of all activities.

Northwestern University Makes Large Chicago Additions

Four large buildings have been completed by Northwestern University on the McKinlock campus, at Chicago, which supplements the main institution at Evanston, Ill. These are the Montgomery Ward Memorial Building, 14 stories, with 19 story tower; the Wieboldt Hall of Commerce, eight stories, and including a power plant; the Levy Mayer Hall of Law, four stories, and the Gary Law Library, three stories. These buildings represent a total cost of $4,500,000. The associated architects were James Gamble Roberts and Childs & Smith. For the two larger buildings the general contractor was the R. C. Wieboldt Co., the steel being supplied and erected by the Hansell-Elcock Co. For the two law buildings the J. B. French Co. had the general contract. It is expected to begin within a year or two the Thorne Memorial Auditorium, which will seat 1,000 people. The only other buildings definitely planned for the Chicago site are the Passavant Hospital and Wesley Hospital, which may be built within the next three or four years.

At the Evanston campus, the new stadium has been built and fourteen sorority houses are nearly completed. Numerous other buildings planned, but for which no funds are yet available, include a science hall, library, chapel, women's building and gymnasium, general meeting hall, and two or three dormitories. Also, additional engineering buildings and facilities if the proposed amalgamation with Armour Institute of Technology is carried out.

Lake Water Projects for Illinois Inland Cities

A project for delivering water from Lake Michigan to a hundred towns within about 35 miles of Chicago, with an estimated aggregate population of 750,000 in 1930, has been given a preliminary permit by the Illinois Commerce Commission, but the final design and the franchises from these towns must be submitted to the commission for approval. This project, of the Greater Chicago Lake Water Supply Co., provides for an intake shaft opposite 22d St. and two to four miles from shore, with a tunnel extending to a main pumping station and filter plant just west of the Chicago city limits, a distance of about ten miles.

An alternative plan would locate the tunnel and pumping station just beyond the north line of Cook County or opposite Highland Park, Ill. From the pumping station, lines of mains would be laid westward and southward, through groups of towns extending as far as Elgin, Aurora and Joliet. These mains would aggregate 250 miles of 66-in. to 12-in. pipe. The company is incorporated in Illinois and its financing has been arranged through Putnam & Storer, the Stone & Webster Co., E. H. Rollins and Brown Brothers.

The preliminary estimate of cost is about $35,000,000 and it is intended to begin work as soon as the necessary franchises have been obtained and approved. S. M. Savage, Chicago, is chief engineer, with Mortimer G. Barnes and Walter M. Smith as consulting engineers. This is one of two similar projects, noted in *Engineering News-Record* of July 9 and Dec. 17, 1925, pp. 76 and 1008.

The Municipal Water Co. proposed a less extensive system with an intake shaft and tunnel opposite Kenilworth, Ill., north of Chicago, and a pumping station and mains serving 21 towns with an estimated population of 420,000 in 1940. The estimated cost was $8,000,000. This company was not granted a permit but has applied for a rehearing. Its engineers are Alvord, Burdick & Howson, of Chicago.

Bills for Export of Power and Storage Defeated in Maine

A bill providing for the export of surplus power from the State of Maine, which was vetoed by Gov. Brewster on April 16, failed to receive the necessary two-thirds vote of the Senate required to over-ride the veto and so will not become a law. Gov. Brewster vetoed the bill on the ground that it does not provide adequate control over power which would be transmitted outside of the state under the proposed bill. He based his decision upon a ruling by the state's attorney general that the proposed method of control might be declared invalid, thus putting the exportation of power beyond the control of the state.

Difficulties between Maine and New Brunswick over the importation of power from New Brunswick into Maine became a possibility when the Maine legislature, on April 15, killed a bill to incorporate the Fish River Power & Storage Co. The latter company, a subsidiary of the International Paper Co., proposed to build a storage reservoir on the Fish River, one of the tributaries of the St. John River, in order to increase the prime power at the power plant now being built at Grand Falls, N. B., by the International Paper Co. At the present time power is being imported into Aroostook County in Maine from Aroostook Falls in New Brunswick, under a temporary permit and it is feared that this permit may be revoked if the Maine legislature will not co-operate in developing the St. John River.

South Philadelphia Bridge to Be Studied

A legislative bill signed by Gov. Fisher of Pennsylvania on April 11 provides for creating a commission to make studies for a second Delaware River bridge at Philadelphia, to be located between Snyder Ave. and the mouth of the Schuylkill River, in the southern end of the city. Eight commissioners for Pennsylvania are to act with a similar New Jersey commission. New Jersey has already passed a like bill and appropriated $50,000 for the study, which with $25,000 each appropriated by Pennsylvania and Philadelphia will provide a fund of $100,000 to cover the full cost of the investigation.

Plans for B. & O. Terminal in Philadelphia Outlined

Tentative plans for the proposed new Baltimore & Ohio R.R. terminal in Philadelphia have been agreed upon between the city and the railroad company. Under the agreement, the railroad company will build a new station between Market and Chestnut Sts. and will electrify its tracks within the city limits. The city will make certain street changes incident to the new station construction.

Scaffolding Around Tower of N. Y. Hotel Burns

(*Continued from page 665*)

However, the Board of Standards and Appeals requires that "Standpipe fire lines shall be carried up with each story after the structure reaches the 7th story or a height of 85 ft., and there shall be provided an outside siamese steamer connection in a proper and accessible place and regulation hose outlets at each story above the 2nd floor shall be provided as the work progresses. The top of each riser shall be securely capped at all times during the progress of the work except when work on the standpipe fire line is in progress at that point."

No other equipment is required by the regulations and the fire department has no jurisdiction until the building is occupied. A demand was recently made by the N. Y. Board for other first-aid fire-fighting equipment. There was none in place in this building.

Money for Hudson Bay Railway Work Appropriated

The Canadian Government has appropriated $5,000,000 for the completion of the Hudson Bay Ry. to the Hudson Bay. The Minister of Railways in asking Parliament to vote this amount explained, that in addition to securing the services of Frederick Palmer to report on the comparative merits of Port Nelson and Fort Churchill as terminals for the railway, the government intends to place the areas under a year's air reconnaissance. He stated that while there was no insurmountable obstacles to constructing the railway to Fort Churchill, the government hoped that in view of the expenditure already made on Port Nelson the latter would prove to be the logical location. It will take six years to fully complete the work of dredging the proposed 300-ft. ship channel up the Nelson River. The cost of this dredging would be over $7,000,000; another $7,000,000 would be required for docks, about $5,000,000 for a 4,000,000-bushel capacity elevator and $300,000 for a lighthouse.

Tunnel Body to Function Without State Appropriation

The recent Washington state legislature unanimously passed an act continuing the Cascade Tunnel Commission and making an appropriation of $5,000 for further detailed study in preparation of another report for the next legislature. The appropriation was not approved by the governor and hence the commission will not be supported by state funds. However, funds will be secured from some source, the commission announces, and a further report will be ready for the next legislature.

The commission was appointed to investigate and report on a low-level tunnel through the Cascade mountain range and the first report was presented to the 1927 legislature. John P. Hartman, Seattle, is chairman of the commission. The shortest of several routes under consideration is 29 miles long.

Estimated Cost of Ward's Island Sewage-Works, New York

Too high a figure for the estimated cost of the proposed Ward's Island sewage works, to serve a portion of New York City was given in *Engineering News-Record*, April 14, 1927, p. 627, according to a letter from Kenneth Allen, sanitary engineer, Board of Estimate and Apportionment. Based on a population to be served of 421,000 in Manhattan Borough and 631,000 in Bronx Borough, or 1,052,000 altogether, the corresponding costs are estimated as $7,809,000, $9,665,000 and $17,474,000. Should the sewage from 171,000 persons across the East River, in Queens Borough, he added, the cost would be increased proportionately. Further details are given in a report of Arthur S. Tuttle, chief engineer, Board of Estimate, in a report dated Oct. 1, 1926. Details of other plants on the East River, required in the future, are not yet available.

Washington Notes

THE Yosemite Power Co. of San Francisco has applied to the Federal Power Commission for a license covering a project on the South and Middle Forks of the Tuolumne River. The plan of development embraces the construction of two reservoirs of 65,000 acre-ft. capacity, three power houses and the necessary transmission lines and conduits. It is planned to install equipment sufficient to develop 51,000 hp. The application conflicts with one previously submitted by the Turlock Irrigation District.

LIMITATION of the maximum weight of trucks using a federal-aid highway in intrastate commerce to protect the road bed from damage is a proper function of a state within its police powers, according to the decision of the United States Supreme Court, rendered April 18, in the appeal of R. B. Morris and others against the State Highway Commission of Oregon. The decision affirms that of the lower court.

The complainants, members of the Auto Freight Transportation Association of Oregon and Washington, brought suit for an injunction against an order of the Oregon Highway Commission reducing the maximum weight of trucks and loads using a section of the Columbia River Highway from 22,000 lb. to 16,500 lb. on the ground that the greater weight was damaging the road, which is a federal-aid highway and forms part of an interstate road. The question however did not involve interstate commerce.

The truck owners set forth that under an old state law, they were permitted to carry a maximum weight of 22,000 lb. and that to reduce this maximum was a violation of the constitutional protection of contracts.

In its decision, the Supreme Court, upholding the lower court in having dismissed the appeal, asserts that the order does not appear unreasonable and that inasmuch as the state is charged with maintaining the federal-aid highway, it is a proper function for the state to make reasonable regulations for its use.

THE Washington state law for creation of drainage improvement districts and assessment of charges therein was upheld April 18 by the United States Supreme Court. L. Koelow and other property owners sought an injunction against the commissioners of Diking Improvement District No. 3 of Clarke County on the ground that assessment of benefits had been erroneous. The improvement was to reclaim land on the east bank of the Columbia River. The state Supreme Court sustained the act, and the assessment, and this was upheld.

ASSESSMENTS against the Missouri Pacific Railroad Co. by Road Improvement District No. 1 of Franklin County, Ark., for the construction of a new highway obviously were arbitrary and excessive, the United States Supreme Court held April 18, thus upholding the lower court, although the case was reversed and remanded with instructions for new proceedings to determine the amount the railroad properly might be charged. The assessment was $75,686 and the Supreme Court holds that it should not have been in excess of $15,000. Rolling stock and other equipment of the railroad were included in the assessment. While the railroad will benefit by the highway, in increased traffic it also will have some losses through automobile competition thus made possible, the high court held. It is left to the lower court to determine how much, within the maximum of $15,000, the railroad should pay.

Moran and Moisseiff Retained by Port Authority

Appointment of Daniel E. Moran as consulting engineer on foundations and of Leon S. Moisseiff as advisory engineer of design was announced by the Port of New York Authority on April 16. Mr. Moran is to advise on the foundation work for all four bridges now being built or studied by the Authority. Mr. Moisseiff is to serve on the 3,500-ft. Fort Washington-Fort Lee bridge across the Hudson River and the Kill van Kull bridge from Bayonne to Staten Island.

Canada Refuses to Authorize New Niagara Bridge

A bill which would have authorized the construction of a new highway bridge at Niagara Falls was turned down in the Canadian Parliament last week. The original plan located the bridge below the present upper steel arch, but this location being objected to the promoters offered to change the location to a site just upstream of the existing arch. E. C. Randall appeared for the project, which was supported by the municipal authorities. The park commissions on both sides of the international line opposed, however.

Penn State to Hold Eighth Industrial Conference

The eighth annual industrial conference to be held by that institution will be held at the Pennsylvania State College, State College, Pa., May 13 and 14. The conference subject will be: "The Selection, Placement and Development of College Graduates in Industry." This conference is given yearly under the auspices of the school of engineering, of which R. L. Sackett is dean.

Railroad in Pennsylvania 38 Miles Long Proposed

The Pittsburgh & West Virginia Railway Co. has applied to the Interstate Commerce Commission for authority to construct a 38-mile extension from a point on the west side belt railroad near Cochran's Mill, Pa., through Allegheny, Washington, Westmoreland and Fayette counties to Connellsville. The proposed extension is for exchanging freight with the Wheeling & Lake Erie and the Western Maryland R.R., also a new through route from Baltimore to Toledo and the lake ports.

Random Lines

What the Engineers Are Saying

"It will take five months to carry out all the earth which is to be carried out and if it were all placed upon scales and weighed it would weigh no less than 100,000 cubis yards, as the engineers say."—From the Pittsburgh *Gazette-Times.*

* * *

An Allied Professional

* * *

Is Professional Advertising Ethical?

Sir—The view herewith is of a sign erected near the site of the new shops of the Southern Ry. at Knoxville, Tenn.,

by two "partners" who are building houses there. The sign reads:

"Notice we want to do your building Figer with us Shelton and Gaddis 1415 and 1421 Wester(n) Ave Knoxville Tenn."

* * *

Fair Enough

"Difficulty was experienced in getting water even to the eighth floor because the downward pressure of the water resulting from gravity meeting the upward pressure from the fire engines caused intense strain in the lines of hose, which burst one after the other and had to be replaced."—New York *Times* explanation of difficulty of fighting fire in high buildings.

Personal Notes

RALPH MODJESKI, consulting engineer, announces the removal of his Chicago office on May 1 to the Straus Building, Michigan and Jackson Boulevards. The New York office will continue at 121 East 38th St.

L. WALLACE SAPP, Badin, N. C., is now working for the United Fruit Co. as irrigation engineer on a banana plantation in Guatemala, Central America. Other work which Mr. Sapp has done includes right-of-way and preliminary engineering for the Pennsylvania State Highway Department, engineering sub-division work in Florida and construction of a trestle across the Caloosahatchee River at Fort Myers, Fla., for the Seaboard Air Line, and field work in municipal engineering at Lakeland, Fla.

JOHN W. ALVORD, Chicago, hydraulic consulting engineer, was married April 12 to Mrs. Lucy Fitkin.

H. R. ALBION has been appointed district engineer in charge of the Jacksonville, Fla., office of the Portland Cement Association. Before entering the association's employ in 1926 as a field representative in Florida, Mr. Albion had wide experience in engineering practice, including five years as senior partner of the engineering firm of Albion & Ewing.

ELWYN E. SEELYE, consulting engineer, New York City, announces that there will be associated with him, under the corporate name of Elwyn E. Seelye, Inc., ALBERT L. STEVENSON, HENRY C. LAMB and CHARLES H. HAMILTON. This firm will continue the practice of civil and industrial engineering. Mr. Stevenson is a graduate of Cornell University in civil engineering. Mr. Lamb is a graduate of Cornell holding an M.E. degree.

THEO. HUMAN, JR., who for the past several years has been employed by the township of Teaneck, N. J., as superintendent of public works and municipal engineer, has signed a contract through the Colombian legation at Washington, D. C., to go to Bogotá, Colombia, S. A., for the purpose of making studies for municipal improvements, including sewers and pavements, and to take charge of the construction of them.

H. D. FAULCONER, Dudley, Ky., formerly superintendent for the Rinehart & Dennis Co., has now established his own company, the Faulconer Construction Co., at Dudley for general contracting.

HERBERT E. SPINK, who was assistant engineer in the board of water supply of Providence, R. I., is now assistant engineer for the Metropolitan District Water Supply Commission of Boston, Mass.

H. C. BOYDEN has been appointed lecturer for the Celite Products Co., as announced by the company's Los Angeles office. Colonel Boyden's lectures will embody the results of recent investigations carried on for the determination of the workability of different concrete mixtures as a factor affecting the quality, cost and appearance of concrete.

T. J. TAYLOR, Barnegat, N. J., has joined the organization of the Roy T. Havens Engineering Co., which is in general consulting engineering practice at Point Pleasant, N. J. Mr. Taylor was formerly a chief of field party for the Pennsylvania State Highway Department.

H. C. HOWARD has changed positions from resident engineer for the Florida East Coast Ry. to resident engineer on the construction of a new line for the "Frisco" railway system, running from Aberdeen, Miss., to Kimbrough, Ala.

WM. T. SCHLICHTER has been appointed county engineer of Clay County, Kansas. Previously he served a year as assistant division engineer in Division 2 with the Kansas State Highway Commission and prior to that was resident engineer for the commission at various places in Kansas.

J. M. PORTUGAIS has joined the staff of the Canada Cement Co., Montreal, as technical adviser. Until recently Mr. Portugais was with the Montreal Water Board, working on the construction of concrete bridges and on a street subway. After graduating from Montreal University he was employed on topographical work for the Quebec Commission. Later work was harbor dredging for the Ottawa Department of Public Works and dam and power house construction on the St. Maurice River for the Shawinigan Engineering Co. Before going to the Montreal Water Board he was for some time engaged on the survey of transmission lines for the Southern Power Co. and was in charge of construction of three power stations.

R. H. SHOEMAKER, who has been senior highway engineer of the Bureau of Public Roads of the state of Idaho, has been appointed office engineer in part charge of the Bureau of Highways in the state Department of Public Works. This change was made when the Idaho road department work was reorganized, the office of Director of Highways, formerly held by H. W. GREGORY, being abolished, the Bureau of Highways being controlled by J. D. WOOD, commissioner of public works. The four district engineers in the Bureau of Highways are P. B. WILSON, district engineer at Pocatello; A. N. ASHLINE at Shoshone, P. E. OXLEY at Lewiston, and A. W. BELT at Boise.

MAJOR RICHARD T. COINER, who has been district engineer of the Portland, Ore., District of the United States Engineer Department, in charge of river and harbor works, has been assigned to the office of the Chief of Engineers at Washington, D. C., to report April 30. His work in Washington will deal with power surveys, river improvement, flood control, and similar matters.

DONALD S. MOYES, superintendent of the Quebec Development Co., Ltd., of Ile Maligne, Quebec, has been appointed vice-president of the company to succeed F. H. Cothran, who recently resigned to become chief engineer of the Piedmont Northern Ry.

Engineering Societies

Calendar

Annual Meetings

BUILDING OFFICIALS CONFERENCE, Portland, Ore.; Annual Meeting, Chicago, April 26-29.

AMERICAN WELDING SOCIETY, New York; Annual meeting, New York City, April 27-29.

NATIONAL CONFERENCE ON CITY PLANNING, New York City; Annual Meeting, Washington, D. C., May 9-11, 1927.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston, Mass.; Annual Meeting, Chicago, Ill., May 9-12, 1927.

SOCIETY OF INDUSTRIAL ENGINEERS, Chicago, Ill.; Annual Meeting, Chicago, Ill., May 24-27, 1927.

CONFERENCE OF STATE SANITARY ENGINEERS, Washington, D. C.; Annual Meeting, Chicago, Ill., June 4-6, 1927.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago, Ill.; Annual Convention, Tulsa, Okla., June 6-8, 1927.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Meeting, Chicago, Ill., June 6 to 11, 1927.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; Annual Meeting, French Lick, Ind., June 20-24, 1927.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION, New York City; Annual Meeting, Orono, Maine, June 27-30, 1927.

The St. Louis Engineers' Club at its April 13 meeting discussed regional planning for the St. Louis district. Eight engineers spoke, the majority of whom are members of the Connecting Highways Committee of the Regional Planning Federation of the St. Louis District. They were: A. P. Greensfelder, secretary of the Fruin-Colnon Contracting Co., leader in the discussion; Harland Bartholomew, engineer for the St. Louis Plan Commission; W. W. Horner, engineer for streets and sewers, St. Louis; W. E. Howden, Edwardsville, Ill.; Roy Jablonsky, engineer of St. Louis County, Clayton, Mo.; F. R. Jacoby, St. Charles, Mo.; P. M. Reilley, Hillsboro, Ill., and D. O. Thomas, Belleville, Ill.

The Purdue University Branch of the American Society of Civil Engineers was addressed at its annual banquet, April 12, by L. A. Downs, president of the Illinois Central R.R., and an alumnus of the Purdue School of Engineering of the year 1894, on "Opportunities for Engineers in the Railway Service."

The Engineers' Society of Western Pennsylvania at its monthly meeting, April 19, had an address by Joseph White, engineer in charge of statistics and publicity, Department of Public Works, Allegheny County, on the subject, "The Engineer and Publicity."

The Brooklyn Engineers' Club at its April 14 meeting had an address, illustrated by slides, on "Aerial Photography as an Aid to Engineers," by Charles F. Keale, Jr., consulting engineer.

Construction Equipment and Materials

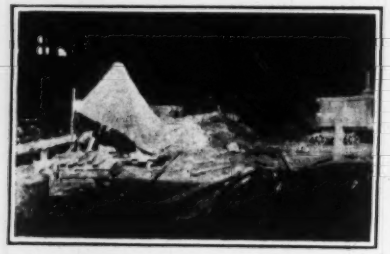
A Section Devoted to What the Manufacturer is Doing for the Engineer and Contractor

Construction Floodlighting

New Plan of Manufacturer Further Evidence of Increasing Thought Given to Night Construction

The increasing use of floodlight illumination on construction work and the need for an engineering service which can work out proper system design, effect the economies possible through careful co-ordination of the equipment used and, where necessary, supply expert supervision of installation, has led The Pyle-National Co., Chicago, to establish a new floodlight engineering service.

The design and layout of floodlight systems have developed to a point



DEMOLITION AND EXCAVATION WORK IN CHICAGO UNDER LIGHT OF SINGLE PROJECTOR

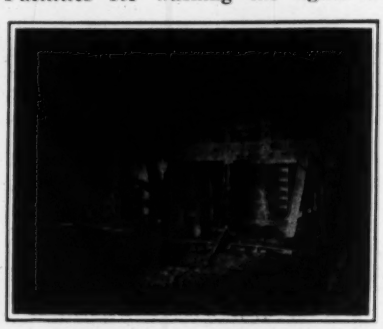
where they are major problems in construction plant planning. The work involves co-ordination of such factors as the design of steel towers, satisfactory distribution and control of power required and a thorough knowledge of the optical and mechanical principle involved in the use of modern floodlight projectors. The Pyle-National plan has been evolved in order to supply this service complete or in part to organizations which either do not have such engineering talent within their own organizations or do not wish to divert several members of their engineering organizations to the job of working out and designing an efficient and economical floodlight installation.

ELECTRIC POWER SHOVEL PROVIDING ITS OWN LIGHT

The service offers to make the entire design of the floodlight system together with complete specifications and bill of material on which actual quotations of material and installation costs will be made. It has been found that there are decided economies to be effected by unifying the design in this manner, and in order to be able to supply all the material for the entire installation the company has extended its line to include all necessary material.

Floodlighting of construction work has developed following the production of high power incandescent bulbs. Formerly arc-lamps had to be used but now incandescent bulbs up to 1,000 watts are available. Another recent tendency has been toward the use of a few large high power projectors rather than a number of smaller units. Advantages claimed for the large units are a reduction in installation costs, and better and simpler control of the system.

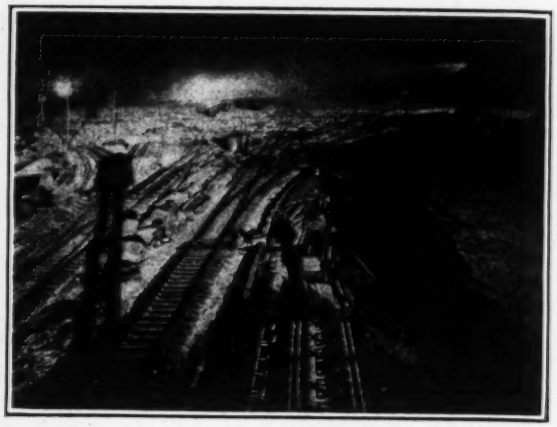
While formerly a silvered reflector was considered to be all that was necessary to spread the light present practice augments the reflector with special lenses. Each lens is designed to produce a different kind of beam ranging from a concentration of all light into one narrow beam to a diffusion of light over a 45 deg. arc. Earlier types of lights were usually of the ventilating type in order to keep the temperature of the inside below dangerous values. In order to keep out dust and smoke general practice is now to use non-ventilating lights utilizing aluminum wherever possible and generally designing for maximum heat dispersion. Facilities for washing the lights on the outside without destroying the focus are often provided. The use of non-corrosive metals is also increasing especially for railroad yard installations.



ELECTRIC FLOODLIGHTING REDUCES FIRE HAZARD IN OIL FIELDS

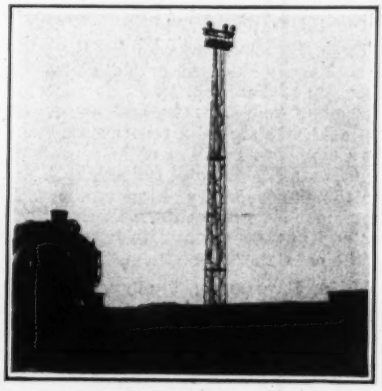
A Special Tower

In co-operation with the American Bridge Co. a steel floodlight tower has been designed by the Pyle-National Co. It is fabricated from standard shapes so that it can be delivered on short notice and at a minimum cost; it can be assembled either with bolts or rivets. Provision is made for the attachment of protective fencing 8 ft. above the base. An inclined safety ladder with intermediate landing stages has been evolved in order to make maintenance safe at night or during storms. Additional safety is provided by placing the ladder inside the tower.



RAILROAD YARD LIGHTING

The basket or platform for holding the lights is 2x8 ft. in plan with a trap door entrance. This platform is surrounded on its four sides by two steel mounting decks, placed one above the other and ready drilled to receive the projectors. The two mounting decks have a capacity of eighteen 23-in. projectors or a much larger number of smaller units.



FLOODLIGHT TOWER IN WABASH YARDS, CHICAGO

Electrical distribution is effected hrough a conduit and eight outlet boxes which encircle the inside edge of the upper deck.

Detachable plug connections serve to carry current from junction boxes to lamps. This permits the maintainer to pull the plug on any individual lamp so that it may be cut out without interfering with the current supply to the other projectors. Individual lamps or smaller banks are available for steam shovel mounting and for separately lighting scattered operations.

Manufacturers Aid Publicity for A.W.W.A. Convention

Much of the pre-convention publicity for the American Water Works Association, which meets in Chicago June 6-10, is being made possible by the co-operation of manufacturers of water-works equipment with the association's committee in Chicago. The old water tower which was built in 1867 and is an historical monument in Chicago, has been selected as the symbol of the convention, and the meeting is accepted as a celebration of the sixtieth birthday of the structure.

In line with this symbol the first item of publicity released was a one-page circular entitled "The Old Water Tower Beckons." Following this is planned a series of six mailing pieces. The titles of these pamphlets and the manufacturers financing them are: "Celebrate with the Old Water Tower," Wallace & Tiernan Co., Newark, N. J.; "Hospitality in Chicago," Sherman Hotel Co., Chicago; "Cast Iron Pipe in Chicago," Cast Iron Pipe Publicity Bureau, Chicago; "Pumping Chicago's Water," DeLaval Pump Co., Trenton, N. J.; "Chlorinating Chicago's Water," Wallace & Tiernan Co., Newark, N. J., and "Water Filtration for Chicago," International Filter Co., Chicago. Each of these pamphlets tells the story of the early history of the Chicago waterworks as related to the product which is being advertised. While each pamphlet has a tone of individuality the series has uniformity in arrangement, size and color.

Concrete Road Yardage

For March the square yardage included in concrete pavement contract awards according to the Portland Cement Association were: 5,134,974 for roads; 3,866,102 for streets; and 298,667 for alleys; or a total for the month of 9,299,743 sq.yd.

The accompanying table summarizes the statistics for the current year:

SQUARE YARDS OF CONCRETE PAVEMENT AWARDED DURING 1927

Month	Roads	Streets	Alleys	Total All Classes
Jan.	2,656,118	1,504,059	75,352	4,235,529
Feb.	2,336,031	1,935,262	119,382	4,390,675
March	5,134,974	3,866,102	298,667	9,299,743
Totals	10,127,123	7,305,423	493,401	17,925,947

Business Notes

NOVO ENGINE CO., Lansing, Mich., has appointed the following new distributors: Construction Equipment Co., Columbia, S. C.; San Antonio Machine & Supply Co., San Antonio, Texas, with branches at Corpus Christi and Waco, Texas; H. E. Erickson Co., Inc., 114 S. Third St., Minneapolis, Minn.

EDWARD A. MOSS of Cleveland, Ohio, has been elected vice-president of the J. E. Moss Iron Works. Mr. Moss was connected with the company in its early stages, and left in the early part of the war to enter the service of the government. After the armistice, he engaged in the steel contracting business in Cleveland.

LUTHER G. MCCONNELL has resigned as vice-president of the North American Cement Corporation to become an officer in a New York bank. FREDFRICK A. BOEYE has been made vice-president, continuing his duties as general sales manager. THOMAS J. HARTE has been made assistant sales manager.

Manufacturers and Trade Associations

Calendar

Annual Meetings

AMERICAN WELDING SOCIETY, New York; Annual meeting, New York, April 27-29.

NATIONAL LUMBER MFRS. ASSOCIATION, Washington, D. C.; Annual meeting, Chicago, April 28-29.

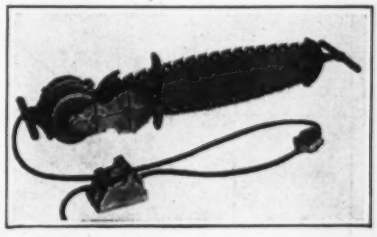
NATIONAL LIME MANUFACTURERS' ASSOCIATION, Chicago; Annual meeting Chicago, April 28-29.

WATERWORKS MANUFACTURERS ASSOCIATION, New York; Annual meeting, Chicago, June 6-10.

New Developments

Portable Link Sawing Machine

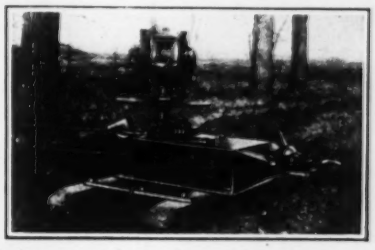
An electrically operated sawing machine, the blade being mounted on endless sprockets is a new product manufactured by Reed-Prentice Corp., Worcester, Mass. It is claimed that the machine performs all the services of



cross-cut saws in one-third to one-quarter the time and with much less physical effort. The saw may be handled by either one or two men and can be used in confined spaces since no stroke room is required. The machine is driven by 220-volt, 60-cycle, 3-phase power circuit or by a portable motor generator set. The saw links are made of individual pieces, consisting of raker and cutter links, link pins and bushings. The action of the saw links is the same as that of a rigid saw and all possibility of buckling is claimed to be eliminated since the rakers and cutters act in opposition to each other. The links on the cutting side of the machine travel toward the motor, thus always keeping the machine against the work and eliminating fastening. Three sizes are available in capacities of 2, 3 or 3½ sq.ft. a minute in soft wood and 24 to 30 in. in diameter. Horsepower ratings of the motors are 2, 3½ and 4.

Land Clearing Machine Operated by Tractor Power

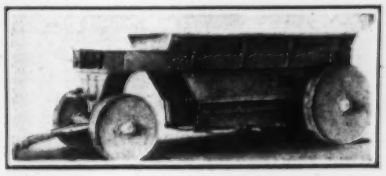
The land clearing machine shown in the accompanying illustration is a recent product of the John Waldron Corp., New Brunswick, N. J. It is designed for endless cable operation with Fordson, Cletrac Model "K," McCormick-Deering 10-20 or 15-30 or Caterpillar 2 ton, "30" and "60" models. It may also be operated by straight-



away pull by horses or tractors. The machine is known as the "Handy Andy Senior." Drums and drive wheels are mounted on skids as shown. The machine is anchored to a stump or tree. It has a 50,000 lb. drum line pull, and by using one block this may be increased to 100,000 lb. The weight of the machine without the cable is 780 lb. It is constructed of steel with bronze bearings, and 55 in. long, 34 in. wide and 28 in. high overall.

All-Steel Tractor Wagon

Built in capacities of 3 yd. and 6 yd., the 6-yd. unit being illustrated below, the all-steel tractor wagon, manufactured by the Rex-Watson Corporation,



Canastota, N. Y., provides earth-moving equipment for operation by either 5-ton or 10-ton tractors. Two 3-yd. units, each with a wheel base of 106½ in., may be operated by a 5-ton tractor in an 18 to 20-ft. cut. The loading height of both wagons may be varied for steam shovel or elevator grader work. Roller bearings are used on both units. In the construction of these tractor wagons an endeavor has been made to eliminate all unnecessary wearing parts in order to insure a unit that will provide the greatest length of service.

Business Side of Construction

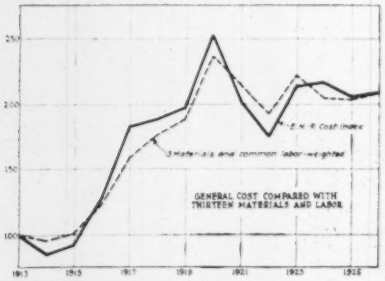
Facts and Events That Affect Cost and Volume

Growing Stability of Construction Costs Indicated by Extensive Survey

Weighted average of thirteen basic materials evidently settling at a point one hundred per cent above 1913—Labor costs show unbroken trend upward during last five years—Narrowing down of the range between yearly high and low quotations marks definite movement away from the violent fluctuations of war-time and post-war periods.

PRICE fluctuations are the sources of profit or loss, with luck playing a prominent rôle. Price stability, on the other hand, eliminates a good deal of the speculative element. These charts are intended as a graphic representation not only of the trend but also of the growing stability of construction costs. The heavy line is the index of the yearly average while the shaded area represents the spread between high and low quotations.

The price data were obtained from the recent compilation, "Engineering News-Record Construction Costs," of high, low and average quotations of thirteen construction materials and five building trades. All prices were first reduced to percentages of 1913 in order to bring them to a comparable basis. Whenever figures were available prices from different sections of the country were averaged together so as to smooth out as far as possible fluctuations due solely to local conditions.



INDEX OF FOUR ELEMENTS COMPARED WITH ONE COMPOSED OF THIRTEEN

The chart for white lead was plotted from New York City quotations only, but it was felt that this particular market represents fairly well fluctuations over the country as a whole. Hollow tile is another material represented only by the New York district.

The other prices are averages of those in the following cities:

Reinforcing Bars—Birmingham, New York, Pittsburgh.

Common Brick—Birmingham, Chicago, New York.

Cast-Iron Pipe—Birmingham, Burlington (N. J.), Chicago, New York, St. Louis.

Portland Cement—Birmingham, Boston, Chicago, Cleveland, Detroit, Jersey City, Minneapolis, New York, Pittsburgh, St. Louis.

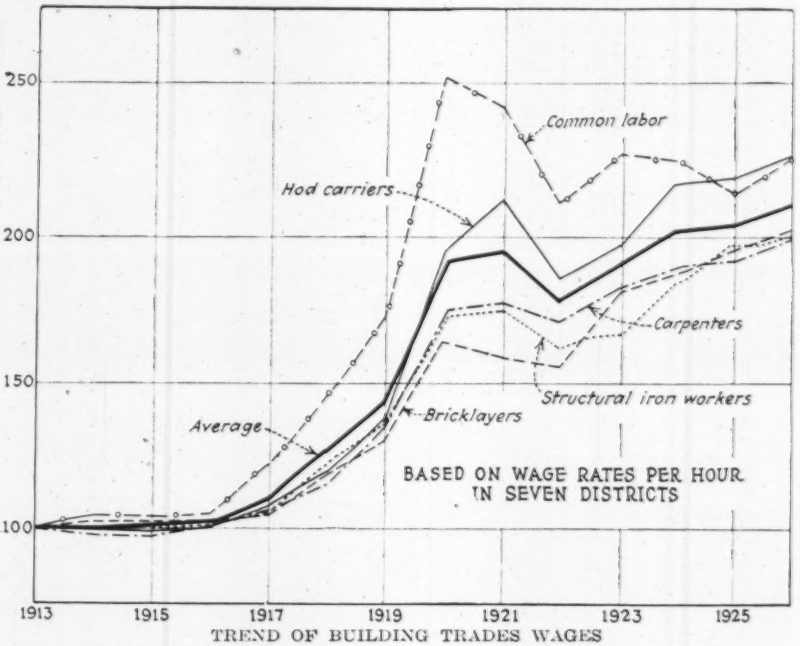
Crushed Stone—Birmingham, Boston, New York, St. Louis.

Gravel—Birmingham, Boston, New York. Lime (common lump)—Birmingham, New York. Linseed Oil—Chicago, New York.

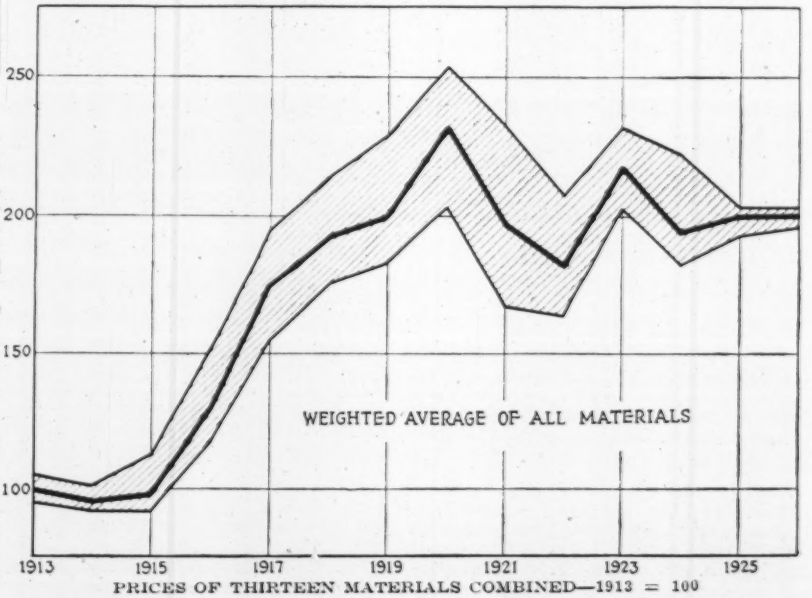
Lumber, Pine—Birmingham, New York.

Sand—Birmingham, New York.

(*Continued on p. 674*)

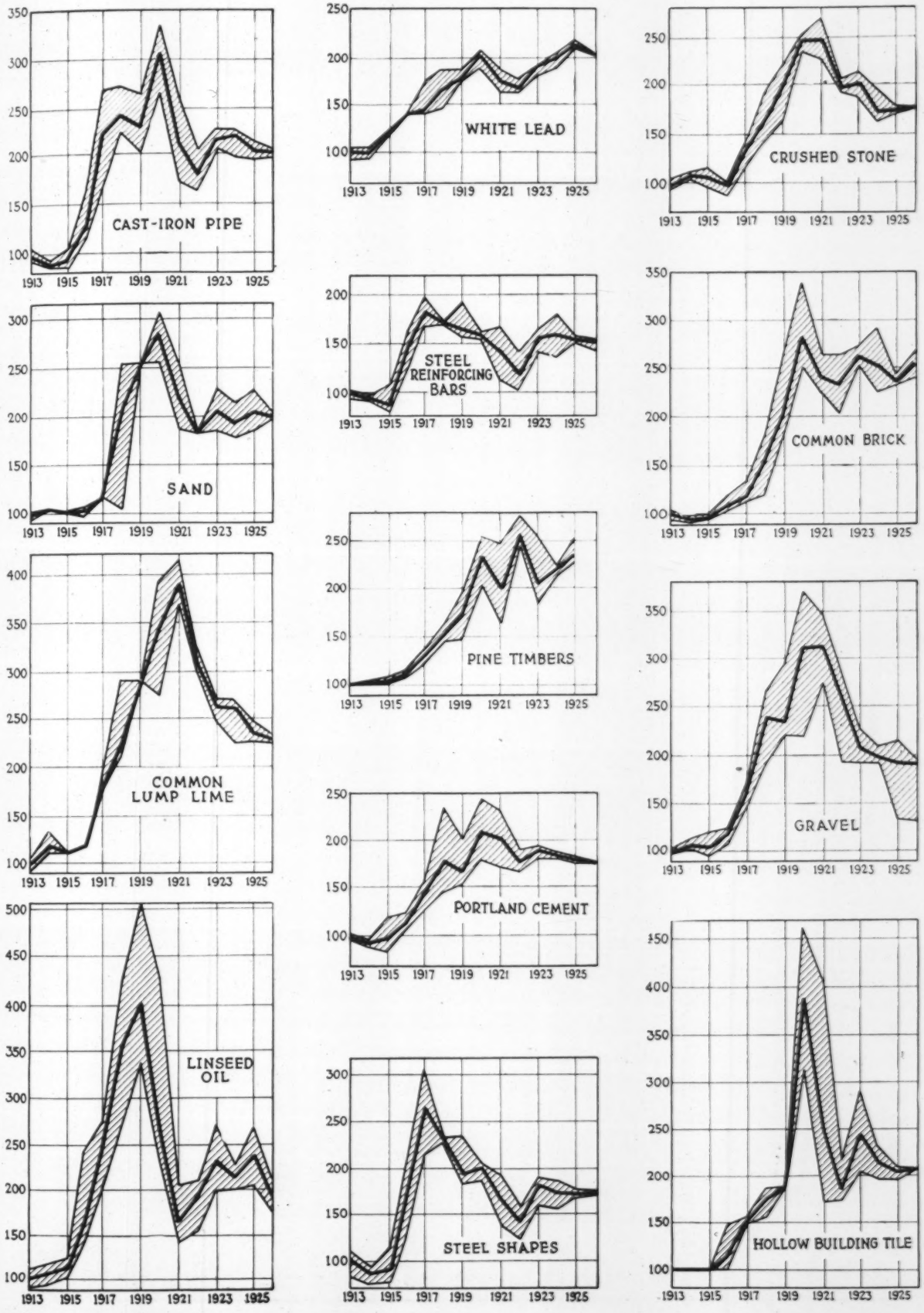


TREND OF BUILDING TRADES WAGES



PRICES OF THIRTEEN MATERIALS COMBINED—1913 = 100

Price Range on Thirteen Specific Materials For Country as a Whole Since 1913



Growing Stability of Construction Costs, Etc.

(*Concluded from p. 672*)

Steel Shapes—Chicago, Pittsburgh.

Labor Rates: Bricklayers, structural iron workers, carpenters—Boston, New York, Chicago, Birmingham, St. Louis, San Francisco, Seattle.

Hod carriers and common labor: same as above with exception of Birmingham.

Prices of materials rose rapidly during the war years, the peak in most cases being reached in 1920. This was followed by a sharp decline until 1922. Then came another upward turn in 1923 with a gradual decline thereafter.

The years 1925 and 1926 show a remarkable stability—Portland cement, hollow tile and white lead registering but little change during the past year. Gravel is the chief exception to this statement regarding stability, but it is probable that the variation in price is partly due to seasonal factors. Linseed oil is another material that does not show any growing tendency toward stability, the fluctuations being about the same as in pre-war years. Lumber, brick and sand, although evidencing a much greater stability at present than during the war years, have nevertheless a wider range between high and low when compared to 1913.

The skilled building trades move very closely together and almost always in an upward direction—there being only one slight decline after the peak of 1920. The curve of common labor has a striking similarity to that of materials, both in the direction and the amount of change. Wage rates of hod-carriers move logically between those of the skilled trades and common labor.

A brief description of the materials used in this study, together with base sizes, quantities, shipping conditions, etc., follows:

Reinforcing bars, steel, ¾-in. and larger, per 100 lb., f.o.b.

Common brick per M; Cast-iron pipe, 6-in. and over, Class B and heavier, per net ton, f.o.b.

Portland cement per bbl. or four bags, exclusive of the bag charge, f.o.b.

Crushed stone, ¾-in. per cu.yd., f.o.b.

Gravel, ¾-in. per cu.yd., f.o.b.

Lime, common lump, per bbl., at warehouse.

Linseed oil, raw, 5 bbl. lots, per 7½ lb. gal., f.o.b.

Lumber, long-leaf, yellow pine timbers, rough, 3x12 to 12x12-in., 20 ft. lengths and under, per M ft. b.m.

Sand, per cu.yd., f.o.b.

Structural steel shapes, beams, channels, angles, tees, etc., 3-in. and larger, per 100 lb., f.o.b.

White lead, dry or in oil, base price, per 100 lb. keg, f.o.b.

Hollow building tile, 10x12x12-in. per block, f.o.b.

All prices of materials are in cargo or carload lots, to contractors. Labor rates are per hour for an eight-hour day.

The "all materials" index is weighted according to the value of the annual production of the various materials.

Weekly Construction Market

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb	$3.34	$3.80	$4.15	$3.10	$3.35	$3.87½	$3.00	$3.15	$3.80
Structural rivets, 100 lb	5.00	3.80	4.75	3.50	3.75	4.65	5.00	3.75	....
Reinforcing bars, ¾ in. up, 100 lb	3.24	2.80	2.75	2.30@2.50	2.87½	3.87½	2.95	2.75	3.57
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	54%	51%	48%	41%	42@53.8%	48%	37.83
Cast-iron pipe, 6 in. and over, ton	48.60	42.00	56.00	46.20	48.50	56.50	47.00	55.00	62.50
Concreting Material									
Cement without bags, bbl	2.35@2.50	2.35	2.05	2.05	2.22	2.85	2.51	2.65	1.15
Gravel, ¾ in., cu.yd	1.75	1.90	2.38	1.85	1.65	1.90	1.80	1.25	1.90
Sand, cu.yd	1.00	1.60	2.00	1.65	1.25	1.00	1.40	1.25	1.35
Crushed stone, ¾ in., cu.yd	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft	61@63	34.00	56.00	40.50	38.75	33.25	27.00	23.00	50.00
Lime, finishing, hydrated, ton	18.20	22.00	19.00	20.00	25.50	24.00	27.50	24.00	21.00
Lime, common, lump, per bbl	2.10@3.00	1.50	1.82	1.50	1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	19@20	12.00	14.10	12.00	13.75	9@10	14.00	—14.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.076	.072	.085	.....	+ 10	.10
Hollow partition tile 4x12x12, per block	— 1027	.0895	.112	.076	.072	.085	.108	+ 10	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal	.83¼	.89¼	1.10	.83	.93	+1.06	.89	.95	1.05
Common Labor									
Common labor, union, hour	.90½	.30	.....	.90	.....	.50@.55	.60	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	.....	.45@.60	.40@.45	.50	.....	25@.30

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor—Cement and concrete laborers' rate, $1.06¼; building laborers, 90½c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots. Steel pipe under 3-in., 51% off list.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Apr. 7, the next on May 5.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) carlots; shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) carlots; shapes, l.c.l.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.125). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) and shapes, in carload lots.